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VANLOO'S PORTRAIT OF CHRISTOPHER COLUMBUS.

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WE are indebted to the *Revue Illustrée* for the accompanying engraving of Columbus, which is taken from the celebrated portrait by Vanloo, and now preserved in the Duke of Alba's gallery, Madrid. The portrait is said to have been painted in America. It is two yards and nine inches high and a yard and one inch wide. The likeness differs considerably from the generally accepted picture of the great admiral.

[FROM THE TECHNOLOGY QUARTERLY AND PROCEEDINGS OF THE SOCIETY OF ARTS, BOSTON.]

THE PHOTO-MECHANICAL PROCESSES.*

By S. R. KOEHLER.

THE photo-mechanical processes which are so largely employed at present for the production of printable pictures, to be used either in books and periodicals as illustrations or independently for the portfolio or for framing, derive their name from the fact that the action of light (Greek, *phos, photos*) on substances which are sensitive to it is called into play in the making of the blocks or plates from which the impressions are to be taken, and that these impressions are produced in the printing press, which is a *mechanical* contrivance. Their ultimate aim is to replace the older reproductive and interpretative processes by simpler, cheaper and more reliable methods. As compared with these older processes, their modern rivals may be divided into two classes: *First*, those the final technical result of which is identical with that of their predecessors; *secondly*, those the final technical result of which is different.

To the *first class* belong those processes which reproduce relief engravings (wood-cuts and wood-engravings), or drawings specially made to imitate them; those which reproduce or imitate line engravings, etchings, aquatints, mezzotints and other varieties of intaglio engraving, and those which reproduce or imitate planographic prints (lithographs and zincographs), executed either with pen and ink in lines or stipple, or with crayon, etc.

To the *second class* belong those processes which, although they produce relief blocks to be printed on the book press like ordinary wood-engravings, differ from the latter in the methods by which they arrive at the gradations from black through grays to white (such as the various grain processes, mezzotype, half-tone screen processes, etc.), but more especially the collographic process and the Woodburytype. The two processes last named are absolutely new, not only in this that they can work directly from nature without the intervention of the artist—a faculty which they share with the half-tone relief processes, the photogravure (intaglio) processes and some of the photo-planographic processes—but also in the printing forms yielded by them, which are absolutely without analogues in the older reproductive processes.

To be able to understand the working of the photo-mechanical processes it is indispensable to have an understanding of the aim of the older processes, and of the means used by them to reach this aim, and we shall therefore have to devote a part of our time to their consideration.

The ultimate aim of all picture-printing processes is to produce blocks and plates which, when properly inked and pressed against a sheet of paper or other suitable material in a press, shall give a picture in which the gradations from black through the various shades of gray to white have the same relations, and therefore produce the same effect, as in a black and white drawing made by an artist, either in lead pencil, charcoal, crayon, India ink washes, gouache or black and white oils. Three methods can be used to reach this end:

1. *Relief engraving*, such as wood-cutting and wood-engraving. Those parts of the surface which are to produce the picture are left standing in relief above the mass of the material used (commonly boxwood), while the whites between them which are not to print are cut away. If a roller charged with printing ink is passed over a block so treated, those parts only which have been left standing in relief take up the ink. If a piece of paper is then pressed against the block, the ink is transferred to it from the surface, and the result is an impression.

2. *Intaglio engraving.* In this case the lines and dots which are to produce the picture are cut into the plate used (intagliated), so that they form furrows and pits in it. The plates are usually of metal (copper, steel, etc.), and the furrows and pits are produced in them by cutting instruments (gravers, etc.), or by chemical means, that is to say, by corroding the metal by acids or mordants (etching). If a plate so treated is covered with printing ink and its surface carefully cleared so as to leave only the furrows and pits filled with it, and if then a piece of paper is pressed against it, the latter lifts the ink out of the furrows and pits, and the result is again an impression.

3. *Planographic methods.* These methods, best known as lithography (from *lithos*, stone) and zincography, are so called because the printing is done from perfectly plane surfaces, neither cut in relief nor intagliated. The process is a chemical one. The picture to be printed is drawn on the stone or zinc with ink or crayon containing soap. The whole surface is then treated with certain chemical agents which decompose the soap, and at the same time attack the stone or zinc. The chemical action induced causes the fatty acids in the soap to enter into insoluble combinations with the stone or zinc. The printing surface now consists of two materials differing in properties. Those parts on which the drawing was made are formed of an insoluble soap, which has the quality of shedding water, and therefore accepting fatty substances even after it has been wet; while the parts not drawn upon accept water readily, and therefore cannot take up fatty substances after they have been moistened. It follows that, if such a planographic surface is wet and then inked—printer's ink being a fatty substance—the drawing alone will accept the latter, while the parts not drawn upon will reject it. Naturally, if a piece of paper is pressed against a surface thus prepared, it will take up the ink from the drawing, and once more the result will be an impression.

* Read January 14 and 30 and February 25, 1892.

The principles underlying these three methods, *relief*, *intaglio*, and *planographic*, will have to be borne in mind if the answer to the question next to be considered is to be understood. This question is: How can the methods under consideration be utilized to reproduce or imitate a picture made in black and white by an artist?

The means at the command of the artist are these: Black masses and white masses; black lines and dots; gray lines and dots of varying intensity or shade (value); and structureless grays, that is to say, masses of gray, either flat, but of varying intensity or shade (value), or gradated, and showing neither lines nor dots perceptible to the eye.

The *relief processes*, it is evident from what has been said, are *surface printing processes*, that is to say, the ink is taken up by those parts of the surface left standing in relief; and it may be said, therefore, with sufficient accuracy for the purposes of this discussion, that the impression produced upon the paper is uniformly black, or, in other words, that every line and dot in the impression is of the same value.* The limitations as well as the capacities of the relief processes are sufficiently apparent from this: Black masses are easily produced by allowing the surface to stand; white masses as easily by cutting it away. Black lines and dots evidently can be produced with the same ease, but it is absolutely impossible to produce really gray lines. Such lines can, therefore, be only simulated by substituting for them narrower black lines, thus reducing the quantity of black and increasing that of white; or by white lining a black line of the same width as the gray line, that is to say, breaking up the black line into a series of dots so that the proportion of black and white in it shall be the same as in the solid gray line of the original, and the effect upon the retina when the dotted line is seen at a sufficient distance to allow the black and white dots to blend shall also be the same. It follows from this that structureless grays are likewise beyond the reach of the relief engraver, and that he can only simulate them by masses of intermingled black and white lines and dots so proportioned that, by blending upon the retina of the eye when seen at the proper distance, they will produce the sensation of a shade of gray of the same value as the structureless gray of the original.

The *planographic processes*, being likewise *surface printing processes*, share, speaking generally, the limitations of the relief processes, and offer the same advantages, artistically considered. They can easily produce black masses and white masses and black lines and dots, but they cannot produce solid gray lines, nor really structureless grays. They can, however, simulate them more successfully, because they can produce, by means of crayons and otherwise, grains which are so delicate as to be almost imperceptible to the naked eye even at very short distances. For the production of crayon drawings the surface of the stone or zinc on which the drawing is to be executed is grained, giving it a texture somewhat like that of drawing paper. According to the fineness of this grain, and the quality—hard or soft—of the crayon used, the character of the drawing can, of course, be varied from extreme boldness to the utmost tenderness.

The *intaglio processes* are more favorably placed in this respect than either the relief or the planographic processes. We shall, however, be compelled to divide them into two groups, as they differ considerably in their capacities, and consequently in the results produced. To the first group belong line-engraving, punching, stippling, and etching in lines. These processes can easily produce white masses, simply by allowing the surface to stand. Black masses, on the contrary, can only be produced by laying black lines so closely alongside of one another that they run together in the impression. This brings us to the most important point in the technical character of all intaglio processes. They are not surface printing processes, the ink being held by the cavities cut or bitten into the plate, and, consequently, they cannot produce absolutely unbroken black masses with the same facility as the relief and planographic processes. This is due to the necessity of cleaning the surface of the plate before the impression can be taken—an operation which is performed with rags or with the hand. If sufficient care is used, the rag or the hand will not enter the lines, thus leaving them filled with ink while cleaning the surface. But if the attempt were made to produce a large, black spot, by hollowing out a correspondingly large spot in the plate, such a spot would produce only a gray smudge in the impression, for the rag or hand would enter it in wiping and would remove the ink from it. This explains why a black spot can only be produced by cutting a series of lines very closely together. The ridges left standing between the V-shaped furrows formed by the lines supply a support for the rag or hand, and thus prevent the wiping out of the ink. Gray lines may, of course, be simulated by narrow black lines, as in the surface printing processes. But the advantage which the intaglio processes have, because they are not surface printing processes, comes in here as an aid in the production of lines of different value. It is obvious that a line cut into the plate may differ not only in width, but also in depth, and that a deeper line will actually deposit more ink on the paper than a shallower one. Such lines may, therefore, differ in value in the impression, and thus the intaglio engraver who uses lines and dots has not only their breadth or size to aid him in producing the appearance of grays of differing value, but he can utilize, also, their varying depth.†

The processes which belong to the second group, such as mezzotint and aquatint, appear at first sight to be entirely independent of lines and dots, and capable of actually producing full black and structureless grays of every possible value. This, however, is not true, as the following consideration will show. Mezzotints are produced by first breaking up the surface of the plate into countless microscopic pits, separated from one another by equally minute ridges of metal, and then, by scraping, reducing the height of these ridges as needed. The breaking up of the surface of the plate—the laying of a mezzotint ground, as it is somewhat improperly called—is performed by an instrument known as the rocker. If a plate so grounded or rocked is inked, and then wiped and an impression printed from it, the latter will present one unbroken mass of velvety black, the minute cavities which hold the ink lying so closely together that the black dots produced by them run into one another, while, nevertheless, the ridges of metal between them form a sufficient support for the rag or the hand to prevent the wiping of the ink out of the cavities. The work of the engraver now consists in reducing the ridges between these cavities by scraping, as before stated, very slightly where there is to be a dark gray, more decidedly where there are to be lighter grays and removing them entirely where there are to be whites. By this scraping the ridges are reduced in height, and, consequently, the cavities between them in depth, so that as the scraping proceeds downward they hold less and less ink. At the same time, however, the tops of the ridges of metal—the ridges broadening downward—become wider and wider, and, therefore, the black spots produced in the impression by the ink taken up from the cavities are separated from one another by more and more of the white paper seen between them. The various shades of gray in a mezzotint are the result, therefore, of two factors—the varying quantity of ink deposited on the paper according to the varying depth of the cavities, and the difference in the spacing of the dots produced. It is quite possible to lay a mezzotint ground so fine that it is difficult to detect the discontinuity of the grays with the naked eye; but it exists, nevertheless, as without the supporting ridges between the cavities, which form the ink-holding grain or tooth, all the ink would be wiped out of them. This is true also of aquatint, although in this case the cavities are the result of etching, and the grain produced is rarely so fine as to escape observation.

It is needless to tell you that these old hand processes—processes, that is to say, in which all or nearly all the work had to be done by the hand of man—have produced most admirable work, which will be the admiration of all ages to come. Nevertheless they are open to certain objections. But, before I undertake to state these objections, I wish to have it understood most distinctly that I am not going to act the part of the *advocatus diaboli*. On the other hand, I am not concerned at present with æsthetic theories or even fashions in art. My business is simply to give you historical and technical facts.

The first objection, then, to these old hand processes is their costliness, a necessary result of the high class of artistic labor employed in the production of really good work, and of the length of time needed for engraving a block or plate, such time reaching from months into years, and the prices paid from hundreds into thousands. There is a tendency noticeable, therefore, throughout the whole history of the reproductive or multiplying arts to substitute the forces of nature for the work of the hand of man. The first effort in this direction is coeval almost with the very beginning of picture printing, for etching, which seems first to have been practiced for the purpose we have in view toward the end of the fifteenth century, is, technically considered, nothing else but the substitution of chemical action for the work of the graver. The same is true, but in a still higher degree, of lithography, which was invented toward the end of the eighteenth century. It is the direct outcome of the desire alluded to, for although its invention may be called an accident, yet it must not be forgotten that Senefelder was consciously experimenting with the purpose of finding a cheap and easy substitute for the then known processes of engraving. Had that desire not been present the "accident" might have occurred a thousand times without leading to a result. The rapidity with which lithography spread over the world also shows that it met a long-felt want—a want which gives a distinctive character to the whole period from the end of the eighteenth to the middle of the nineteenth century.

This period may be called the era of "substitute processes," under which name I have grouped together all the methods devised prior to the introduction of the photo-mechanical processes, for producing printable blocks and plates with less labor, and therefore cheaper than the processes hitherto in use. The aim of all of these processes was to get rid of the engraver—"the emancipation of the artist and the publisher from the engraver," to quote a euphemistic phrase then invented—or to enable the designer himself to be the engraver, by providing means for transforming the design into a printable block or plate by chemical or galvanic action, etc. To tell the bare truth about these processes they are, with isolated exceptions, the outcome of the industrial rather than of the artistic development of modern times. It is not their purpose to supply the artist with new means of expressing his individuality. They strive to imitate something more costly, by methods capable of rapid and extensive utilization in large industrial establishments. Cheapness is with them the first consideration, with as much artistic perfection as this limitation will allow; and their career was only cut short by the introduction of the photo-mechanical processes, which served the same ends still better and offered, besides, as we shall presently see, other advantages which were not offered by the substitute processes. Most of the latter have, therefore, gone out of use again, although some of them still hold their ground for certain classes of work, and, within certain limits, with excellent results. I allude here to the wax processes and kaolatype or clay surface processes (from *kaoline*, China clay), which may be summarily described as follows: Metal plates are covered with a thin coating of wax or of a clay preparation, and the design is cut into the coating with suitable tools so as to lay bare the metal. By electrotyping in the case of the wax processes, and by stereotyping in the case of the clay surface processes, blocks are obtained showing the design in relief lines, and these can be printed in the book press like wood cuts. It is impossible to give a description here of all the processes which belong to this group;* but a word must be said concerning the relief etching process, not only because it was the earliest of its fellows, but also

* The slight possibilities of variation offered by underlaying and overlaying are ignored here, nor can the difference between black line and white line engraving be considered.

† The aid to be derived from wiping and what is known as *retroussage* is ignored here as not properly the work of the engraver. The printer of process plates, moreover, can also make use of these devices, if they suit his purpose.

* For further details see the catalogue mentioned at the end of this paper.

because the experience in etching gained by those who practiced it was a great help in the development of that form of the photo-mechanical processes most extensively used to-day. Relief etching is a substitute for wood engraving and is merely the reversed application of the etching process long known to painter-etchers and engravers. In this latter process the lines that are to print black are bitten into a metal plate, and those parts that are to show white in the impression are left standing.

It is evident that in relief etching those parts which are to print black must be left standing, while those that are to show white are bitten away. To obtain this result different methods were essayed. The metal plate was covered with an etching ground, and the parts that were to show white were removed, or the design was executed on the plate in a fatty ink capable after it had dried of resisting the action of acids, or it was drawn on prepared paper in similar ink and was then transferred to the plate by pressure (in the press), the prepared paper being carefully removed after it had been wet from the back so as to dissolve or soften the preparation on its surface. This "transfer process" plays an important part, also, not only in lithography, but in some of the photo-mechanical processes, and it will be necessary, therefore, to keep it in mind. Of the etching involved—the biting away of the metal between the lines—it must suffice here to say that it is a much more complicated process than that employed by the painter-etcher or even the engraver. But of this more anon.

The objection to the old processes which the substitute processes sought to overcome was purely commercial—their costliness; and all they sought to do, therefore, was to reduce the labor of the engraver to a minimum, or at the very utmost to do away with it entirely. There was and is, however, a second objection, which takes a higher ground—the unreliability of hand processes considered from a scientific point of view. Necessarily when an engraver copies an artist's design, either from nature or a creation of his genius, it must undergo a transformation, owing partly to the technical limitations previously outlined and partly to the individuality of the engraver. In the case of a design from nature the influence of subjectivity is, indeed, still greater, for the transformation worked by the individuality of the engraver is preceded by that of the draughtsman, since it is a well known fact that two designs by two different men from the same scene or object are never alike. We have, indeed, become much more skilled in copying than our predecessors used to be, so that copying might almost be called a modern art. To realize this it needs only to compare modern work of the same kind with say Rubens' copies from paintings and antiques, or the architectural etchings of the artists of past periods, or, still later, some of the reproductions of Mexican and Central American antiquities, which in many cases are little less than translations into a bastard Renaissance style. But even with all our progress in this direction there are still so many possibilities of uncertainty that, with the awakening and growth of the modern scientific spirit, there awoke and grew, also, a desire for a process able to produce printable pictures—pictures, therefore, capable of wide distribution—which should be entirely free from the influence of subjectivity, and, consequently, absolutely correct scientifically, so far at least as form and light and shade are concerned. The reproduction of color has, indeed, also been essayed, but that is a subject which cannot be touched upon in these lectures.

Now it is evident that a such a reproductive process must be absolutely independent of man, and must rest entirely upon the action of the unerring laws of nature. The outcome of the search for this desideratum was the discovery of the photo-mechanical processes and of photography. In the mind of the public photography has become so closely identified with the usual form of portrait photography, etc., in which not only the printing form used (the negative), but also the so-called print (the positive, in the shape of silver prints, platinum prints, carbon prints, etc.), is the result of the action of light on substances affected by it, that it is looked upon as its starting point, while the photo-mechanical processes are supposed to be later applications of the principle involved. It is nevertheless true that the very first experiments made by Joseph Nicephore Niepce aimed at the production of printable plates, and that the daguerreotype and photography on paper as we at present know it are later developments. The difficulties besetting the production of printable plates were so great, however, that the experiments made in this direction were obscured by the splendid results achieved by sun printing, and were only prosecuted with renewed vigor—although never wholly abandoned—when it became evident that the products of photography, pure and simple, were too expensive and too unstable to supply the place of pictures in printer's ink printed on a press.

The aim followed in these researches—the discovery of a scientifically reliable reproductive process—is very clearly expressed in the announcement of the prize offered by the Duc de Luynes in 1856: "It is," says this announcement, "with a view to hastening the moment so much desired, when the processes of printing or of lithography shall permit the reproduction of the marvels of photography *without the intervention of the human hand in the design*, that M. le Duc de Luynes . . . has established a prize." These hopes were based on the assumption that photography was actually scientifically reliable. It is hardly necessary to say that this illusion has long since been dispelled, and that we are to-day fully aware that there are a thousand and one influences at work which make the result of photography doubtful, even if we leave out of the calculation the errors of judgment introduced by the still unavoidable intervention of man, not only as a chemist and physicist (optician), but to some extent also as an artist (in the choice of pose, point of view, lighting, etc.) But even if we had a method eliminating all these sources of error—a sort of "drop-a-nickel-in-the-slot-process," in which absolutely everything is done by nature—there would still be varying conditions of light, of moisture, of temperature, of electricity, which would affect the result, and it is probably vain to hope that these difficulties will ever be completely overcome, or their causes brought under control. In spite of all these limitations, however, it remains true that on the whole photography is, scientifically considered, the most reliable delineator at present at our service. If we add to this the commercial advantages offered by it, its rapid development and wide diffusion are easily explained, while at the same time we may confidently assume that the end is not yet, and that a long line of development and improvement is still before us. With all these shortcomings, therefore, present to our mind, we shall be unable to deny that the photo-mechanical processes represent a vast step in advance on the road toward the desired aim, which is nothing less than the elimination, not only of the *engraver*—whom the substitute processes had already sought to oust—but also of the *designer*, from the production of printable blocks and plates. To take any object, whether artificial or natural—a work of art, a scene in nature, animals, the human face and figure—and to produce therefrom, solely by the agency of nature, a printing form from which an unlimited number of impressions can be taken in ink as unaffected by the ravages of time as that used for the printing of blocks and plates engraved by hand—this is the aim of the photo-mechanical processes.

(To be continued.)

BURNED CLAY.*

L. J. HOWARD, St. Louis, Mo.

Mr. President and Gentlemen of the National Brick Manufacturers' Association:

When I began to consider this subject practically I was really amazed at the vastness of the task I had set myself.

"Burned clay, why that is a simple subject," the layman might say; "a discussion of brickmaking covers the ground."

Burned clay is intimately connected with the development of civilization in the world. What would be our cities without burned clay, for their dwellings and business edifices, our country land without burned clay for the draining tiles that reclaim whole counties from the marsh and make the State richer? How could our great centers of population now do without burned clay for conduits of all sorts, water pipes, sewer pipes, gas pipes and the pipes for the electric wires?

How plain and bare and ugly and uncomfortable would be the houses when they were built without the burned clay that makes the ornamental terra cotta, the beautiful tiles, the useful fire brick and the thousand varieties of earthenware that now seem absolutely indispensable to the housekeeper. One gets up in the morning and thanks burned clay for the utensils that give his breakfast, for the vessels from which he takes it, and for the heat that diffuses itself through the house as he eats. He goes out and burned clay prevents him from sinking into the mud. He enters his office and goes through his day's work, burned clay contributing in a hundred different ways to his comfort during the day. Whether he works, sleeps, or amuses himself at the club, he would find, if his attention were directed to that point, that he owes much to burned clay, which has played a great part in the history of the world. . . .

Neither in Greece nor in Rome did they fancy burned brick in the old days. Greece resorted to its stone quarries and Rome to its forests. It was not until Rome conquered Egypt and brought some of the country's brickmakers to the Eternal City, seeing the importance of brickmaking to the prosperity of a city, that burned brick was used at all there. The Egyptian brickmakers in Rome were the first to burn brick in kilns. The brick were used principally in facing walls of concrete, and ruins show that they were placed about four to a foot on the face, which is about as we lay them now. For the first three centuries of the Christian era the kilns in Rome were busy. One thousand years later all that part of Europe seems to have forgotten how to make brick. The Romans conquered Great Britain and taught the Britons how to make brick, but as soon as the conquerors left the country the Anglo-Saxon pulled down the kilns and went back to wood, so great was his hatred of the invader.

Years after the Britons began to use stone, and 1260 A. D. the first sign that brickmaking had begun again in the country was seen in a Suffolk building, Little Wenham Hall. From that time on burned brick became more generally introduced in the country, which was but following the example of other nations. About the seventeenth century the manufacture of burned clay into brick and ornamental articles had become universal in the world. The art had grown from the hands of a crude people within the previous five centuries.

Italy led in the beauty of its burned clay. Its palaces depended largely on burned brick, and inside them and outside were the most elaborate designs of colored decorated brickwork and ornaments of terra cotta and tiling. Holland was then using brick for all of its solid buildings, but few other purposes. When the great fire burned London down in 1666, the city was rebuilt almost entirely of brick, and many of the houses of the wealthy were decorated with ornaments in brickwork.

The first brick brought to our own country were used by Wouter von Twiller, of Amsterdam, who came to Manhattan Island in 1633 and built a large house for himself, as well as several smaller ones for the officers of his colony. All these brick actually burned in this country were made in New Haven in 1650 by the little colony planted there. Virginia had good clay, but the colonists did not use it, preferring wood. In Pennsylvania from the earliest times brickmaking was pushed vigorously. In 1705 the Philadelphia court house was built, the first pretentious brick edifice put up in this country. It cost £616, about $3,080; its brick cost over $7 a thousand, and the bricklaying $3.50 a thousand. Boston did not use brick, but wood, like Virginia. Its first great brick building was a warehouse, erected by London merchants in 1700. About this time English vessels began to bring over brick for ballast to the colony, and the use of brick became common. Little was made in this country. Inventors tried to construct devices, but none of the brick was as good as that which came from England and Holland. All the brick was being made by hand up to 1835, when Nathaniel Adams invented a machine in Philadelphia. It was simply a hand moulder, but was quite successful. A model of it is now in the Patent Office. In 1840 Adams undertook to start a brick yard in Philadelphia, but the hand brickmakers broke the machine and drove Adams from the city. At that time hardly a million brick were used yearly. In the year 1888 the cities of New York, Chicago, Philadelphia, St. Louis, Boston, Cincinnati, Washington, Cleveland, Pittsburg, Omaha, New Orleans and Indianapolis produced 2,755,000,000.

I shall not consume the time of this body by entering on any description of the different kinds of clay or machines which I prefer, or which I think should be used. There is too much diversity of opinion on both these points for me to attempt to decide the question. Generally speaking, the clay that is most accessible to a city will be used for its buildings, with exceptions depending on fancy or business opportunity. We are fortunate in this country as to our supply of clay. There is plenty of it and it is generally good. Near enough to all great cities bare beds of clay great enough for our needs for a longer time ahead than we can see. There is no country that has finer clay, or more of it. Russia has good clay, but makes little use of it. The product there for 1890 was a little over 1,000,000,000 brick—not half of the product of this country. We have as good kaolin or china clay in this country as the Chinese ever saw, and these clay banks furnish from one thousand to four thousand tons a year to each of about seventy-five potteries. The independence of the United States in the matter of clays of all sorts is shown by the small quantities we import. The last figures which I have been able to obtain showed an annual import to the United States of 46,551 tons of clay, valued at $319,202. Of this, 16,113 tons were kaolin, valued at $132,663, and the same year the kaolin produced in the United States amounted to 23,277 tons, worth $200,457—much more than we imported.

We are equally fortunate as to terra cotta and fire clay; we have all we want at our doors.

With these clays the modern brickmaker can undertake with confidence the manufacture of any material on which depends soundness and finish. The improvements in machinery, of which I am glad to see by the programme we shall hear at length, have strengthened the hands of the brickmaker, so that he need not distrust his machines after he has got his clay. The improvement in the method of burning has kept pace with machinery. Wood, of course, has been nearly entirely abandoned. It would take over 3,000,000 cords of wood to burn our output of brick of all kinds now. Coal has become our chief dependence, and experiments are being made with oil and with artificial gas generated at the kiln. Inventors are now concentrating their attention on the burning, and there is no reason why we should not have great improvements within the next few years.

We need principally greater economy in fuel burning and a more perfect combustion.

Had I time I should like to say a word about the progress of the art of burning clay as it is shown through some of its more modern products. The pressed and ornamented brick are the most familiar illustrations. What would the Philadelphians have thought, looking on the crude result of their first attempt at building a brick house, if they could have seen a modern house with a front of our lustrous, velvety pressed and ornamental brick?

Of our fire brick we can well be proud. On this branch of the brick-burning art depend many other manufactures of great industrial importance, which could not be carried on at all without the assistance of fire brick.

We could have no good furnaces without fire brick, no crucibles for metallurgy, no retorts for gas works and zinc works. Pots for the use of glass makers are also made of fire clay, and I am glad to say that the manufacturers of glass are coming to the conclusion that their own fire clays are just as good for this purpose as those of Germany. Our fire clay is also used for sewer pipe and terra cotta wares, and enormous quantities of it are consumed in this way.

The drain tile we make have led to valuable scientific discoveries. Capt. Walter Blythe, an Englishman, in 1862 called the attention of the public to the damage to the land caused by water standing on it. England then introduced the drain tile, and our tile makers took the idea and went far ahead of the original suggestion. In one mart of this country—I think it was in Indiana—the draining of a valley discovered an immense and valuable bed of clay. Ten years ago 700,000 miles of drain tiles were laid in Illinois alone, and the consumption has grown enormously since then. There is now a great and increasing demand for draining tiles from every agricultural State.

Roofing tile are one of the most beautiful developments of the art of burning clays. They made these tile in the time of Ezekiel, the prophet, but the Israelites had no notion of coloring them; in fact, they were used something as we now use slates.

"Thou also, Son of Man," said the prophet, "take thee a tile and lay it before thee, and portray upon it the city, even Jerusalem."

The Assyrians, fond of ornament, colored their tiles, and the Romans used them about the third century. The Greeks preferred marble to burned clay. In Rome both flat and round tiles were used, and sometimes the roofs had both kinds alternating. In times of war tile were used as weapons, women and children mounting the roofs and throwing tiles down on the heads of the enemies in the streets. The garden of the Louvre, in Paris, is called the Tuileries, because the tiles were made there in ancient times. The tile has become more popular as civilization advanced. Modern roofs, covered with tiles, make houses look picturesque, and add greatly to their appearance, relieving the monotony. Besides this, the great advantage of the tile roof is that, being a non-conductor, it is cooler in summer than any other kind of roof, and is a protection against lightning. In fact, pottery is now coming into general use for insulators on electric lines.

The use of ornamental tiling indicates that a nation has both leisure, wealth and proper appreciation of the beautiful. Burned clay did its utmost when it produced the exquisitely colored pavement tiles of Xerxes, or Ahasuerus, the husband of Esther, of the Bible. The Bible describes the floor of his palaces as a pavement of red and blue and white and black marble, yet it was only tiling, the tiling which any plain American

* Read at the recent convention of brick manufacturers, at Louisville, Ky.—From the *Clay Record*.

citizen can get now to make his house beautiful. The walls of Babylon were partly glazed tiles, like ours, and it is probable that about this time, 521 B. C., all the arts of the tiler were known.

We learned how to glaze and fix the colors on the tiles through the Arabians, who got the knowledge from the Chinese. In mediæval times the tiles were called Norman tiles, because the Norman crusaders found painted tiles in Palestine, and began to make them when they got back to England. After that the beauty of the art caused people everywhere to adopt it. Palissy and majolica, variations of the tile, were invented, and artists spent their lives in discovering new methods of glazing and enameling. The Vatican is paved with colored glazed tiles, put there by Leo IX. The mosaic tile came to us from Greece, but the clay dust tile with relief figures is an invention of England.

Terra cotta is another form in which the burned clay recommends itself to the eye of the beauty lover in architecture. The pure buff color is now seen ornamenting the facade of many important buildings erected in our large cities.

Among the most remarkable modern uses of burned clay is the ballasting of railways on our Western prairies, where it is hard to find satisfactory materials for this purpose. This clay costs fifty cents a ton. Artificial teeth, for which dentists' charges vary, are made of burned clay, and the consumer pays many thousands of dollars for burned clay in this form. A peachblow vase is another form in which burned clay is immensely valuable. Not long ago $12,000 was paid by Mrs. Morgan, of New York, for one of these vases. Clay in the form of this peachblow vase brought about a quarter of a million dollars a ton. Gold and silver, or any other precious metal, will hide its diminished head before burned clay, when the art of man has been lent to its service, when its value can be indefinitely increased.

If I went into the subject of porcelain, or Sevres, or Dresden, or Satsuma, or Royal Worcester, or any of those dainty and costly products of burned clay, I might interest the ladies, but I should overrun my time. I may conclude, as I said at the beginning, that burned clay is much more to the life of the ordinary man than he believes, until he begins to think about it.

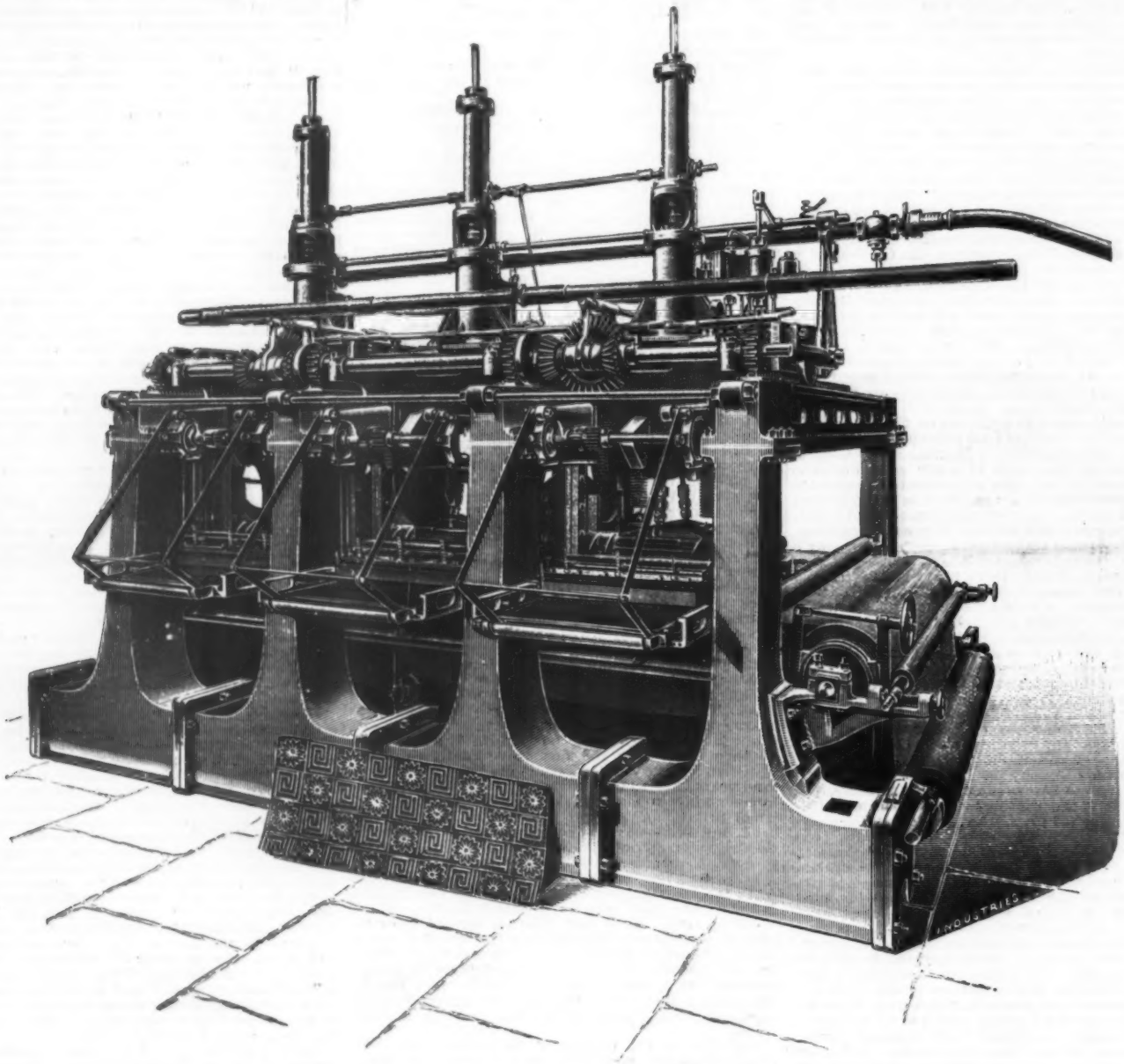
And we are just commencing to find out what possibilities lie in it.

It is claimed there is a lighthouse to every 14 miles of coast in England, to every 34 miles in Ireland, and to every 39 miles in Scotland.

IMPROVED OIL CLOTH PRINTING MACHINE.

Of the many varieties of floor covering offered to the public, floor cloth, sometimes called "oil cloth" and linoleum during more recent years, are the most appreciated. The difference in the composition and manufacture of these goods is very great, for while both are formed upon a canvas backing, the former is essentially a hand-made article, while the latter is a machine-made article. There are, indeed, cheap qualities of floor cloth made by machinery, but to these we are not now referring.

Floor cloth of the better quality is all hand-made, in pieces eight yards wide and twenty-four yards long. The foundation, as we have said, is of canvas, and the body of the cloth is made by spreading a paint, composed chiefly of oil and whitening, in successive layers upon the canvas. After each layer has been put on it is dried by means of hot air. The pattern is printed upon it by means of hand blocks about 18 in. square, upon which the pattern is cut in wood or metal; these are placed upon the cloth in proper rotation, being guided by suitable gauges, and pressed "home" by screw presses. The designs are often elaborate, and necessitate frequently the use of six to eight colors.



IMPROVED OIL CLOTH PRINTING MACHINE.

Linoleum, on the other hand, was patented by Mr. Fred Walton, and is manufactured, until the expiry of the patent, by the Linoleum Company, at Staines. It was originally made only two yards in width until Messrs. Nairn & Co., Kirkcaldy, took up its manufacture. This firm produce it four yards wide.

Linoleum, as its name signifies, is composed of oxidized linseed oil and cork. The composition is rolled upon the canvas foundation by means of heavy calenders, and the printing is chiefly done in the same way as that upon floor cloth. We say chiefly, because several machines have been made for this purpose. One type of machine, suited for printing linoleum two yards wide, has blocks two yards long; but an objection to this type is that the blocks are expensive to make and repair. Another type is the roller machine, in which the pattern is cut upon a roller or circular block, as in calico printing.

The machine illustrated herewith, which has been patented by Mr. Thomas Dale, Kirkcaldy, N. B., can be made to print floor cloth and linoleum of any width and uses the same blocks as employed in hand printing, producing work of the same high quality. The machine shown is for printing three colors at the rate of about 5,000 square yards per week, when running the usual working hours. It consists of a table supported upon a strong cast iron framing, at one end of which is a roll of unprinted linoleum. The cloth is carried along the table by steel bands provided with teeth passing over a card roller at the outer end; from this roller, after printing, it is delivered by the action of the machine into the drying stove or rack. The framing which carries the table also supports a series of horizontal beams, corresponding with the number of colors to be printed, and of any length to suit the width of the cloth. Upon these beams move a series of frames; each frame carrying a cylinder for moving it along and working the blocks. Above the main cylinder, which is 6 in. diameter and has a stroke 11½ in., is a cataract cylinder, 2⅝ in. diameter, for controlling the speed of the machine. The machine is worked throughout with compressed air.

The valves working the air cylinders are of the usual type, and are actuated by a 3 in. auxiliary cylinder fixed upon the end frame; this has also a cataract cylinder, and its valve is controlled by the up and down strokes of the printing block. The printing block holder is not attached directly to the crosshead of the piston rod, but is coupled to it by double links. The center joints of these links form the ends of levers, having their fulcrums on the horizontal shafts at each side of the frames. These links form an arrangement whereby the blocks travel at a speed varrying from that of the pistons; the speed of the blocks is slowest, and the consequent force or pressure greatest, when the blocks are nearing the cloth. By this arrangement the blocks leave the cloth quietly, and by a simple contrivance the block holder first lifts at one edge, the action of the block being exactly similar to that in hand printing. To the levers above referred to are fixed toothed quadrants, which actuate the gear for moving the frames across the cloth, and also smaller quadrants for the pad movement.

The blocks receive their color from a pad, which is moved in below the block, and upon which the blocks descend to receive their color, the pads are then moved away to allow the blocks to print. The tiering of the pads is done by a simple arrangement of rollers receiving the color from suitable color pots. The arrangement for moving the cloth along on the table is very ingenious, and is operated by compressed air. A chain attached to the end of the piston rod of a small cylinder works a pawl and ratchet wheel fixed to the card roller at the end of the machine. This is made to haul round the roller at the required time, by an automatic valve, which is tripped off after the last square at each side of the cloth is printed alternately.

The machine is independent of any outside gearing or driving arrangement, being only connected to the compressed air cylinder by a flexible tube. It can be placed upon any ordinary printing floor, and may be mounted upon wheels for the purpose of moving it

from place to place in front of any one of a series of drying stoves or racks. It is compact, so that the attendant can move round it conveniently to inspect the work as it proceeds. The space occupied is 10 ft. 3 in. in height, 11 ft. 6 in. in breadth, and 13 ft. 6 in. in length. It has been put into successful operation at the works of the Kirkcaldy Linoleum Company.—*Industries.*

TEMPERATURE REGULATOR FOR INCUBATORS.

THE utility of incubators is a fact recognized by every one, and the great variety of forms of the apparatus that are now found in the market sufficiently proves the extension that the use of them has taken.

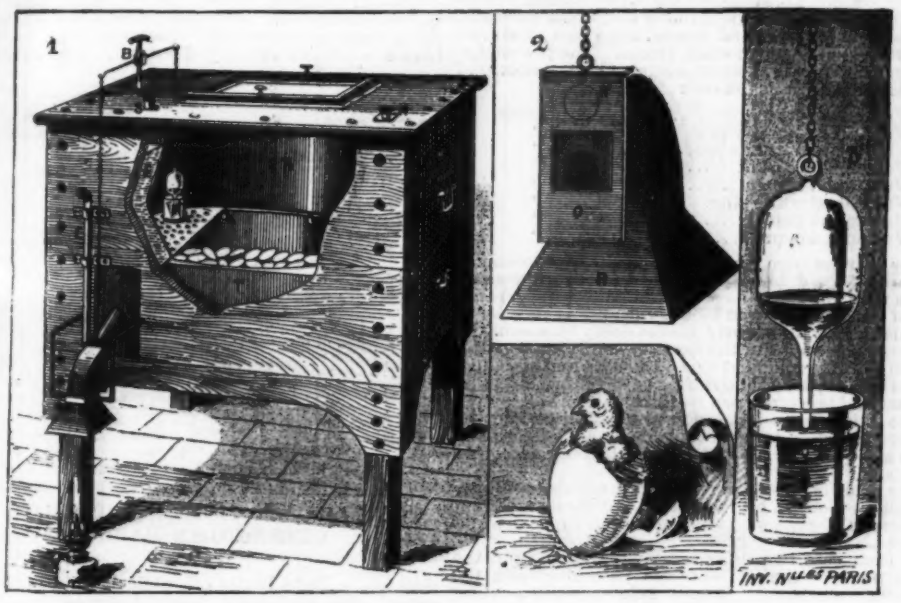
All these apparatus, however, are based upon the same principle, to wit, the construction of a box in which is constantly maintained the temperature necessary for the hatching of eggs. In order to attain this result, it is therefore indispensable to be able to regulate the distribution of the heat automatically, and that too by means of apparatus of extreme sensitiveness that operate as soon as the temperature in the interior of the incubator tends to vary in one direction or the other from the normal.

It is principally in the methods employed for establishing such constancy of the temperature that the various systems of apparatus known are distinguished from each other, and it may well be said that very few of them have solved the question in so simple and perfect a manner as the incubator represented in our figures.

The apparatus consists of a wooden box provided with four legs, and whose interior is lined with sheet metal. This box receives a zinc receptacle, F, of oval form and of such dimensions that there exists between its external surface and the sides of the box a space, E, in which may circulate water kept at nearly a constant temperature by means of a heat distributor that we shall speak of further along.

The receptacle, F, receives an oval vessel, T, whose height is about half that of the box, and in which the eggs to be hatched are placed.

The cover of the box is provided with an aperture,



TEMPERATURE REGULATOR FOR INCUBATORS.

1. The Incubator. 2. Distributor. 3. Regulator.

N, designed for the introduction of water into the space, E, as well as of a pane of glass through which operations may be watched.

The heat distributor consists of a spiral tube that traverses the water in running around the receptacle, F. One of the extremities of this tube makes its exit at S, above the cover, and the other expands into a sort of hood, R, provided with a square part in which a lamp is placed. A waste tube, C, communicates with the principal tube designed to heat the water.

The aperture, H, of the tube of square section connecting the hood with the principal tube is closed automatically according to circumstances by means of a register, O, suspended by a chain from one of the arms of the lever, B. An ampulla, A, with a capillary tube dipping into the water of a vessel, V, placed in the interior of the incubator and suspended by a chain from the other arm of the lever, B, balances the register, O.

Supposing the temperature to be too low, the ampulla, A, is in such a case almost full of liquid, and, consequently, its weight overcomes that of the register which partly closes the aperture, H. But when the temperature rises, the air compressed in the upper part of the ampulla expands and drives before it a volume of liquid so large that the weight of the register, O, overcoming that of the ampulla, A, closes the aperture, H, again.

There exists a position of the register corresponding to a nearly stationary temperature. Such position is obtained when the volumes of air and liquid contained in A are equal.

The arrangement just described forms an extremely accurate temperature regulator.—*Les Inventions Nouvelles.*

A NEW extract is prepared in France, and made into tablets which are said to be digestible as raw meat. Lean beef, free from fat, bone and tendon, is pounded to a pulp, mixed with sugar, and heated to about 100 degrees, when the mixture is converted into a saccharine extract. Further heating gives this any desired degree of concentration.

SATIN-CALF.

THIS leather, in its general properties, is very similar to our dongola leather; it is the connecting link, so to speak, between ordinary wax-calf and glove-calf tannages. Satin-calf is almost exclusively used for high-priced and light shoes and finds a principal market in Spain, Italy and South America. As this grade of leather is sold by the foot, the skins best adapted for its manufacture should be flat and of uniform thickness, have full flanks and a perfect grain. The liming of these skins takes about ten days, and they are unhaired out of lukewarm water. Great care is exercised in the unhairing, so as not to injure the grain. After unhairing a second liming is given in a very weak lime for about four days. After shaving the heads the skins are washed in a tumbler drum for a quarter of an hour, and are then placed in a vat of clean water for twenty-four hours. They are now thoroughly worked on the grain side, run in a tumbler drum with warm water and then bated in a bran bate. This bate is prepared as follows:

For 100 skins take 22 lb. wheat bran. The bran is mixed with a large quantity of water and thoroughly plunged. The mixture is then allowed to settle. The shell of the bran will settle to the bottom, while the flour will remain suspended in the water. The water with the suspended flour is run off and fresh water again run on the settlings. After plunging as before and settling, the liquid is again run off, and this operation repeated a third or fourth time. Now the bran is quite free of flour and is soaked in hot water. A pail or two of manure bate is added when this bate is made for the first time, which are replaced by the same quantity of old bran bate in future cases. The absence of the flour has the effect of almost completely preventing acid fermentation of this bran bate and causing a putrid fermentation instead, which acts similar to but much milder than the manure bate. They are placed into this bate and the bate wheel run at intervals of a few hours for about twenty-four hours, after which time they are sufficiently depleted. The above-described bate is also well adapted for other grades of calfskins, possessing the further virtue of a less offensive odor and being cheaper in price. In Italy and Spain satin-calf is tanned exclusively with sumac. The resulting leather, however, is very inferior to bark-tanned leather. Although of a handsome color sumac-tanned leather will not carry grease. A further disadvantage of sumac-tanned leather consists in its invariably being of a harsh, coarse nature, owing to its not being filled with tannin; it is, further, not so tough and durable as bark-tanned leather. All these poor properties are due partly to the sumac itself, but more so to the method of its application.

The method of sumac tanning, as generally employed in the Orient and Southern Europe, consists in sewing together the skins in the shape of bags and then pressing through the strong liquor. The tanning, according to this method, is completed inside of two days. To overcome these disagreeable properties of sumac-tanned leather and still retain the color, it was tried to tan with sumac in vats in the ordinary way. The tanning is completed in about two weeks, but although the quality of leather is considerably improved by this process, it does not compare with bark-tanned leather. The next thing tried was to tan the skins in oak and then bleach with sumac, but as the grain side was bleached and the flesh side was ultimately whitened, this surface coloring was of no use and only produced that certain harshness peculiar to sumac. Willow bark was finally found to answer all requirements for tanning satin-calf and largely adopted by leading manufacturers. The skins are tanned in the usual manner by coloring in paddle wheels, handling and laying away. The tanning is completed in about seven weeks.

The skins tanned with willow bark are of almost white color; they are soft and silky and quite tough. After shaving down to an equal thickness, the skins are soaked in warm water for six hours, and then softened by running in a tumbler drum for ten or fifteen minutes with lukewarm water. The skins are next very thoroughly scoured by hand on the flesh side with the slicker and then the grain receives the same treatment. Special care is taken to work out the creases of the necks. The grain should be well stoned for this class of leather, as it makes it milder. After lightly oiling off, the skins are allowed to "sammy" and then worked out again on the grain. This is accomplished by fastening it on the table with a little French moellon and vigorous slicking on the grain side. The grain is completely pressed down by this working out. The skins are now dried, when they are ready for blacking. The blacking necessitates great care, as the skins have thus far only got very little grease, and consequently the logwood sigg is very apt to strike through. The logwood staining is applied with a brush and well rubbed in, which operation must be quickly performed to prevent the staining from striking through. Only very little soda should be employed in making up the logwood staining for this leather, because it has hardly any grease. After topping with copperas solution the grain is treated with the following mixture: 2 lb. of cake tallow, 3 oz. of beeswax and 6 qts. of cod oil are melted together. This mixture is well rubbed into the grain immediately after the blacking has soaked in. The skins are then dampened and stuffed with a mixture of tallow and moellon; or a mixture of moellon with palm-kernel oil. The stuffed leather is piled up or put to press for several weeks, then whitened and boarded. To obtain a dull gloss the skins are now glassed or rolled.

Another process of finishing satin-calf is employed in several large establishments in southern Germany. After the skins are tanned they are well washed and scoured, and oiled off on grain side with cod oil, and on flesh side with soft stuffing. After blacking they are dried, then moistened and stoned on the grain side, after which they are handstuffed with soft grease on the flesh side and dried. The skins are now whitened and trimmed and seasoned by thoroughly rubbing Barberry juice (vinette) into the grain with a woolen cloth. The skins are now hand-soaked on the flesh side, then glassed or stoned under the jack. In other shops the skins are sumacked, then lightly stuffed. A grease finish composed of one part of beeswax, one part of tallow and two parts of linseed oil is then applied to the grain, after which the skins are ironed and subsequently boarded. Regarding the composition of the blacking for this class of leather we take following receipts from a German contemporary: Ordinary iron blacking is boiled for two hours with some powdered nut-galls and archil, a small quantity of gum arabic and blue vitriol are then added. Another blacking is composed as follows: 4¼ lb. copperas are dissolved in warm water and a strong decoction of 6¼ lb. logwood and 2¼ lb. fustic is stirred in. To this mixture add 1½ oz. castile soap, previously dissolved in hot water, and boil the whole for an hour with occasional stirring. Another good blacking is made as follows: 3½ oz. copperas, 18 oz. blue vitriol, 9 oz. cream tartar and 2 oz. alum are boiled for about one and one-half hours with sufficient water. The leather is well sigged with this and topped with a strong decoction of logwood. The first blacking receipt produces poor results on American tannages, the second blacking formula gives better results, but does not equal our ordinary logwood blacking, while the last blacking receipt might give fair results if we were told how much water to take for the solution.—*The Leather Manufacturer.*

THE HUANCHACA MINE, BOLIVIA, SOUTH AMERICA.

By ROBERT PEELE, JR.

THIS great silver mine, by far the largest producer in South America, if not in the world, is situated at an altitude of about 13,400 feet, in a group of hills on the central table land of Bolivia. It is connected with the port of Antofagasta, on the Chilean coast, by a 30 inch gauge railroad, 395 miles long, built through the influence, and largely by the capital, of the Huanchaca Company.

The mine comprises workings on two main parallel and nearly vertical veins. These veins cut through a small mountain which reaches a height of about 14,500 feet above sea level. Many years ago they were extensively worked to a depth of several hundred feet, but these operations were not successful as a whole; the veins were notable neither for quantity nor richness of ore, and even after a number of native capitalists became interested, and the work of exploration was pushed more vigorously, the future of the mine seemed extremely doubtful. No one imagined it was destined to pay millions in dividends.

During the past fifteen years the gross production has been worth, in United States currency, at least $46,000,000, of which about $15,000,000 has been paid to the stockholders.

According to the official report for 1891, there was still standing in the mine ore containing 15,300,000 ounces of silver. The basis for this estimate, however, is not stated.

Until recently the mine has been worked according to the old Spanish-American methods, human labor to a large extent supplying the place of machinery. But during the past two years a very heavy and expensive plant has been erected, including two large hoisting engines and an air compressor. This machinery is supplied with steam by a battery of six boilers of 200 horse power each.

The workings on January 1, 1892, had reached a depth of 1,190 feet below the level of the main tunnel.

During 1891, according to the company's report, the gross product was 5,942,000 ounces silver, yielding a net profit of $2,050,000 United States currency. Of the total production, 17,193 tons of ore, containing 4,041,000 ounces silver, were exported to Europe, and 13,890 tons, containing 1,894,800 ounces, were treated in the amalgamation works near the mine.

The ore, after hand sorting, assays from 120 to 300 ounces per ton, the higher grade being shipped. The cost of mining, handling, and sorting is about $38 per ton, that of milling, $24 per ton. Though these working expenses are rather high, it must be remembered that the situation of the mine is extremely unfavorable, far in the interior of the country, with inefficient labor and high freights.

The ore consists of a quartzose gangue carrying iron and copper pyrites, galena, blende and tetrahedrite, the latter usually massive but sometimes beautifully crystallized. The tetrahedrite contains the greater part of the value of the ore, and is very abundant.

The following data I obtained in Huanchaca in 1891:

Average Composition of the Sorted Ore.

	Per cent.
SiO_2	28·00
Cu	1·89
Pb	11·30
Zn	21·50
Fe	11·60
S	26·00
As	0·35
Sb	1·80

The ore is pulverized in Gruson ball mills made in Magdeburg, Germany, each mill grinding from 10 to 12 tons per 24 hours to 50 mesh. In these mills 130 pounds of ore are crushed per hour per horse power.

Roasting is now done in reverberatory furnaces, 11·5 feet × 55·5 feet, containing 3 step hearths, fireplace 10 × 3 feet. These furnaces are worked from both sides, 2 shifts per 24 hours, 6 men on a shift for each furnace. Seven charges of 2,000 pounds are roasted per 24 hours. Four per cent. of salt is added on the second hearth, and 25 pounds of fuel (consisting of small scrub wood and brush) are required per 100 pounds of ore.

No attempt is made to chlorinate to a higher percentage than 50 per cent., from 47 to 50 per cent. being found by experience to give the best results in amalgamation. After drawing the roasted ore from the furnace, it is at once spread out on the cooling floor to prevent further chlorination.

Losses in Roasting.

(Figures taken at random from the mill records.)

Values of Ore—Oz. Raw.	Roasted.	Per cent. Loss.
131·4	143·4	2·18
131·5	138·6	0·59
126·0	129·0	0·55
148·8	152·4	2·99

The apparent gain in value of the roasted ore is caused by the driving off of the sulphur. The actual loss in roasting is said to be from 3 to 5 per cent., showing careful and very satisfactory work.

The ore is amalgamated in large "tinas," similar to ordinary amalgamating pans, the charge being 5,500 pounds; time, 4½ to 5 hours; charge of quicksilver, 120 to 160 pounds.

The results of amalgamation are shown in the following table, the values being given in percentages of silver, and the extraction calculated on the value of the roasted ore:

Roasted Ore.	Tailings.	Extraction.	Loss of Hg in oz. per oz. of silver extracted.
0·455	0·036	92·09	0·32
0·453	0·042	90·71	0·42
0·464	0·029	93·75	0·21

Retort silver averages 999 fine; after melting into bars, 994.

The total losses, carefully averaged over a considerable length of time, are:

Loss in transportation and grinding	1¼ to 2 per cent.
Loss in roasting	3 to 5 per cent.
Loss in amalgamating	8 to 10 per cent.
Loss in stealing amalgam	1-10 of 1 per cent.
Loss in melting into bars	6-10 of 1 per cent.

The net extraction varies from 82 to 87 per cent., which indicates remarkably good metallurgical work.

The mine is worked through a tunnel which cuts the veins about 1,500 feet from the mouth. As the amalgamation works are 4½ miles distant, on the opposite side of the mountain, the cost of transportation was, formerly, a serious burden. Several years ago, the main tunnel was continued entirely through the mountain, making a total length of 10,750 feet. It is connected by a gravity road with the reduction works.

Upon the dump of the mine there are between 60,000 and 70,000 tons of ore containing from 75 to 90 ounces silver per ton. This has accumulated in the absence of means to work it at a profit before the railroad was built; but, during the past three years, a large reduction works has been in process of erection on the seacoast near the railroad. The intention is to discard the present mill near the mine, and work all the lower grade material at this new establishment, 395 miles from the mine.—*School of Mines Quarterly.*

THE VULCANIZING PROCESS FOR PRESERVING AND STRENGTHENING POLES, CROSS ARMS, TIES, ETC.*

By HARRY C. MYERS, Ph.D., F.C.S., etc.

WHEN we consider that the annual consumption of timber in this country equals twice the amount of material supplied by the annual growth of our forests, it is apparent that the subject of wood preservation, wood strengthening and the utilizing of certain woods now considered as worthless, is a most important and vital one.

Wood as it occurs in nature consists of cellulose impregnated with resin, volatile oils, sugar, gum, tannin, protein bodies and the usual mineral constituents of plants. The percentage of these various constituents, of course, depends not only upon the kind of wood, but upon the season of year, locality, nature of the soil, and part of the tree from which any given sample is taken. Hence any results or tests would be only approximate ones.

When wood is heated, as in ordinary wood distillation, the cellulose decomposes and a chemical change takes place between it and the natural constituents of the sap, resulting in a most powerful antiseptic mixture, containing acetic acid, methyl alcohol, acetone, methyl acetate, tarry matter containing phenol, creosote, carbolic acid and about thirty other chemicals of lesser practical importance.

* A paper read before the National Electric Light Association, St. Louis, Feb. 28 to March 2, 1893.

The following percentages by weight were distilled from various woods:

Yellow pine	57·8 per cent.
Norway pine	56·8 "
Virginia pine	60·2 per cent. to 72·1 "
Red oak	55·3 "
Spruce	58·7 "
White pine	61·2 "
Poplar	59·0 "
Cypress	59·0 "

It must be borne in mind that these chemicals and antiseptics result from the action of *heat* on the natural sap of the wood, and are *entirely different* from the original sap, which allows of the attack of microscopic fungi and decay. Why has it occurred to no one to heat timber at a temperature which would produce the above change, and then to *keep the changed antiseptic mixture there under pressure*, instead of distilling it *out* of the wood? Such is the entirely new and original process known as "wood vulcanizing," viz., the heating of wood and timber under great pressure.

Hundreds of processes for preserving wood have been patented, and all of them may be divided into two classes: I. Those in which wood is impregnated with a preservative material by immersion. II. Those in which a preservative agent is forced into the pores of the wood. Such chemicals as copper sulphate, zinc chloride, mercuric chloride, dead oil, etc., have been applied, but experience and results have failed to prove them all that is to be desired in an economic and effective means of wood preserving. The poisonous nature of such chemicals makes the application and use of them very objectionable.

In the process of "vulcanizing," wood is heated in closed cylinders from eight to twelve hours at a temperature ranging from 300 degrees to 500 degrees Fahrenheit and under a pressure of from 150 to 200 pounds to the square inch. A circulation of superheated and dried compressed air removes the surface moisture and any water that does not take part in the reaction and combine with the woody constituents. Hence, wood or timber, in any condition, may be immediately treated. These cylinders for the treatment are 105 ft. long, 6½ feet in diameter and are made of steel. As the treatment penetrates to the heart of the timber, considerable time is required for cooling, which is, of course, done in the cylinder and under pressure. Timber is introduced and treated upon cars which run into the cylinder upon small tracks. The percentage of dark antiseptic matter contained in *vulcanized* woods I find to be as follows:

Vulcanized yellow pine	55·3 per cent.
Vulcanized Norway pine	56·7 "
Vulcanized Virginia pine	58·9 "
Vulcanized red oak	54·0 "
Vulcanized spruce	57·9 "
Vulcanized white pine	55·5 "
Vulcanized poplar	59·0 "
Vulcanized cypress	56·8 "

The samples from which these results were obtained were companion pieces to those from which the previous were obtained; a comparison shows the percentage of moisture removed by the vulcanizing process.

This process apparently makes decay impossible by sealing up the pores of the wood with antiseptic matter which becomes solid and firm on cooling and standing, and which is produced *within* the wood by the action of heat and pressure upon its original sap.

The original sap is colorless or pale yellow, and the changed sap very dark or black; hence a most desirable dark antique color may be imparted to oak and other woods.

The following tests were made at the School of Mines, Columbia College, by request of the Western Union Telegraph Company, upon cross arms to be used on telegraph poles.

In each case two cross arms were made from the same piece of timber; one was vulcanized and the other left untreated. Results below give, in pounds, the weight required to break each cross arm:

Vulcanized Norway pine	3,000 pounds.
Natural Norway pine	2,680 "
Vulcanized cypress	2,600 "
Natural cypress	1,860 "
Vulcanized spruce	2,780 "
Natural spruce	2,460 "
Vulcanized poplar	2,840 "
Natural poplar	2,560 "

These startling results show an average *increase* in strength of 18·9 per cent. Similar tests made by Prof. R. H. Thurston and Mr. Alfred Trautwein, of Stevens Institute, verify the above results.

The Hon. B. F. Tracy, Secretary of the United States Navy, with a view of adopting vulcanized wood in naval construction, appointed a committee who visited the vulcanizing works in New York City, made tests of their own on yellow pine, showing an average increase in strength of 18 per cent. and a decrease in deflection of over 13 per cent.; hence they reported that vulcanizing increases the durability and strength of timber, and recommended such timber for use as backing in one of the monitors.

Untreated cross arms which have been painted and used by the Bell Telephone Company for from two to three years showed, by actual test, an average *decrease* in strength by exposure of 18·78 per cent., as compared to new untreated cross arms. Other pine cross arms which had been in service on Western Union telegraph poles for three years and over showed an average loss in strength by exposure of 38·12 per cent. The process of vulcanizing seasons all timber, thoroughly preventing any further warping, checking or cracking. Such timber is not influenced by atmospheric agencies, bacteria or spores, and requires no paint for protection, as it is saturated with antiseptic preserving material of its own; the albuminous constituents of the natural wood have been coagulated by the high heating and rendered insoluble.

Loblolly pine, as it is used in the South, decays in about three years, and is unfit for any railroad construction where it is exposed to the elements. Other woods are seasoned and rendered beautiful by vulcanizing, which produces very desirable colors for interior decoration.

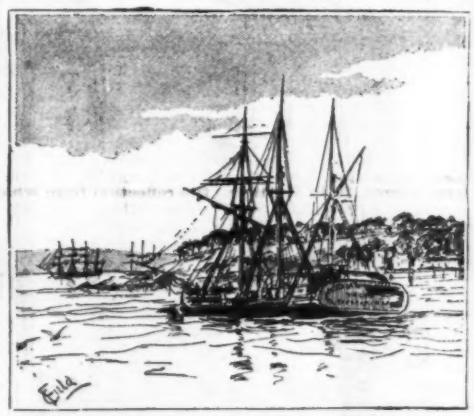
The life of vulcanized timber is not known; none of the timber or ties used in railway construction during the past ten years have been known to decay. I personally examined some 12 × 12 pine timber which had been placed in a machine shop in 1882, part being vulcanized and part untreated. The treated timber is perfectly sound and still in use, while the untreated had completely rotted and crumbled away after five years' use. I also find by personal investigation that timber placed on the Manhattan elevated roads of New York City, as far back as 1883, shows no signs of decay, and is as sound and sweet as if fresh from the tree, while untreated timber laid at the same time has rotted away and been replaced.

As vulcanizing changes the sap from the liquid to the solid or semi-solid state, does not char or make the wood brittle, saturates and seals up the pores of timber with solid matter instead of liquid soluble matter which nature provides, considerable strength and durability are added by vulcanizing, the wood being rendered more cohesive, harder and denser. The spike-holding quality is naturally much increased, and even after ten years' service, railroad spikes seem to be as firmly embedded as when just driven.

It is also a curious fact that the electrical resistance of most woods is very greatly increased by vulcanizing.

AN OCEAN WAIF.

A FEW mornings ago one of the Queenstown pilot boats, looking out for a homeward bound vessel, sighted about eight miles off the Old Head of Kinsale a battered and tattered effigy of a craft, making laboriously its slow and devious course under a foretopsail only. Steering their boat alongside, the crew found that she was the timber ship Velox, which had been abandoned some months previously on her homeward voyage from Acapulco to Bremen, having become waterlogged in mid-Atlantic. The crew of the Velox were landed two months back by the steamer Michigan. The nature of the Velox's cargo had kept her afloat, but, though sighted more than once by passing ships, none of these had been able to bring her into port. So, left to her own devices, she gradually neared land until she eventually made the southwest coast of Ireland. Putting a prize crew on board the salved vessel, the pilot boat next secured the services of a tug and towed their valuable prize into Queenstown harbor. She lies there now with water rising right up to the upper deck, and with her port bulwarks almost entirely destroyed. Her starboard



THE DERELICT TIMBER SHIP VELOX, IN QUEENSTOWN HARBOR.

side, too, is little better off, while her deck house is gutted, the roof only being left.—*London Daily Graphic.*

THE NEW GERMAN FIELD ARTILLERY.

THE new German artillery is said to be the most terrible war instrument ever produced. During the Franco-German war it was considered effective shooting if splinters from a shell were thrown within a circuit of 40 or 50 paces and seldom more than seven or eight men were wounded. The new weapon has much greater destructive power. Experiments made deeply impressed the experts, the Kaiser being present. The first shot, fired at a target placed 50 paces from a wood, missed the target, but plowed its way through the wood for 1,500 ft. Soon after a large area of the wood was seen to be ablaze. The shell was charged with a powder, the composition of which is the secret of the German government. The splinters of a shell burst by the new powder cover a circle of 900 ft. A shell fired at an enormous target, constructed by the Emperor's orders, covered it with thousands of holes. A battery of the new artillery would, it is asserted, annihilate an entire division, once the range was found. The barrel of the new gun is made of cast steel. The caliber is eight centimeters, and the total weight of the gun, limber, and carriage is slightly less than at present. The mobility of the field artillery will thus be increased enormously. The new arm is loaded and fired in one-third of the time required in working the old gun, and the effect and precision are almost double. The carriage and limber is of iron and ironplate. The carriage is supplied with a brake, which counteracts the recoil, the process of loading and firing being thus materially simplified. The limber box is open behind near the gun when in action. The advantage of this innovation is that the projectiles can be served out from the limber and ammunition wagon with greater rapidity. Another important feature is the ammunition. Like the rifle cartridges, it consists of one piece. Ignition is produced by a "ready fuse," and the four kinds of projectiles at present in use—shell, explosive shell, shrapnel and grape shot—give place to a uniform projectile, which possesses the combined characteristics of shell and shrapnel. Explosive shell alone is used. Thus the possibility of a gunner mistaking one projectile for another in the heat of battle is averted, while the loading, aiming, and firing

besides being quicker, is surer and unattended by danger. In short, the new German field gun is simply an enlarged rifle.—*Army and Navy Gazette.*

JAPANESE MAGIC MIRRORS.

AT a recent meeting of the Physical Society, London, Professor S. P. Thompson, F.R.S., made a communication on "Japanese Magic Mirrors," and exhibited numerous specimens showing the magic properties. Referring to the theory of the subject, he said the one now generally accepted was that proved by Professors Ayrton and Perry in 1878, who showed that the patterns seen on the screen were due to differences in curvature of the surface. The experiments he now brought forward fully confirmed their views.

Brewster had maintained that the effects were due to differences in texture in the surfaces, causing differences in absorption or polarization, but the fact that the character of the reflected image depended on the convergency or divergency of the light and on the position of the screen, showed this view to be untenable. Another proof of the differing curvature theory was then given by covering a Japanese mirror with a card having a small hole in it. On moving the card about, the disk of light reflected from the exposed portion varied in size, showing that the curvatures of portions of the surface were not the same. The same fact was proved by a small spherometer, and also by reflecting the light passing through a coarse grating from the mirror, the lines being shown distorted. To put the matter to a test demanded by Brewster, he had a cast taken from a mirror by his assistant, Mr. Rousseau; this had been metalized, silvered and polished, and now gave unmistakable evidence of the pattern reflected from the original.

The true explanation of how the inequalities of curvature were brought about during manufacture had also been given by Professors Ayrton and Perry, but there were some questions of detail on which difference of opinion might exist.

Professor Govi had noticed that warming a mirror altered its possibilities. A thick mirror, which gave no pattern while cold, but developed one on being heated, was shown to the meeting. Professor Thompson also showed that a glass mirror having a pattern cut on the back developed magic properties when the mirror was bent. When made convex, the reflected pattern was dark on a light ground, and when made concave, light on a dark ground. Warming ordinary mirror glass by a heater whose surface was cut to a pattern gave similar effects. Very thick glasses could be affected in this way; on passing a spirit lamp behind a strip of mirror, a dark band could be caused to pass along the screen illuminated by light reflected from the mirror. By writing on lead foil and pressing the foil against a glass mirror by a heater, the writing was caused to appear on the screen.

Professor Thompson had also found that Japanese mirrors, which are not "magic" when imported, could be made so by bending them mechanically, so as to make them more convex. In conclusion, he showed a large mirror, 15 in. by 11 in., the reflection from which showed the prominent parts of the pattern on its back, with the exception of two conspicuous knots; these knots gave no indication of their existence.

Professor Ayrton said the simple mechanical production of the magic property described by Professor Thompson led him to think that some experiments on "Seeing by Electricity" by the aid of selenium cells, which Professor Perry and himself made some years ago, might lead to some result if repeated with thinner reflectors. Speaking of the effect of scratching the back of a Japanese mirror, he pointed out that if metal be removed by pressure a bright image was seen, while if removed chemically a dark image resulted.

Since the original paper on the subject was written he had been led to modify his views as to the effect of amalgamation, for some time ago he showed the society how brass bars were bent if one edge were amalgamated, thus proving that enormous forces were developed. He now regarded amalgamation as an important part of the manufacture.

Mr. Trotter inquired if it had been proved that there was no difference in the metal in the thick and thin parts? One would expect the thin parts to be harder and polished away less.

After some remarks by Mr. J. W. Hearton and Major Rawson, Professor Thompson said the magic effects produced by heating the back of a glass mirror remained for a short time after the heater was removed. The question of whether differences in hardness of the thick and thin parts of a mirror were of consequence in the production of the magic property had been tested by using sheets of brass thickened by pieces soldered to the back as mirrors and found to be unimportant.

ON THE TREATMENT OF DIABETES.

IN the *International Medical Magazine* for July, 1892, there is published a lecture, delivered at the Woman's Hospital of Philadelphia, by Dr. F. P. Henry, in which he makes the following remarks in regard to treatment of diabetes.

The absolute exclusion of starchy and saccharine food is the ideal treatment of diabetes, and if this can be persisted in for at least three months, a certain number of cases undoubtedly may be cured. All kinds of meat, except liver and oysters, may be allowed, and all vegetables except those which contain starch. A desideratum in the dietetic treatment of diabetes is a substitute for bread, the want of which is keenly felt by patients. Some of the samples of so-called gluten bread have been found, on analysis, to contain more starch than ordinary bread. Potatoes contain less starch than bread, and a baked potato is probably the least injurious form of amylaceous food.

In most cases, at least in early stages of the disease, sugar will soon disappear entirely from the urine if the patient be placed upon an exclusive proteid diet. If such a regimen be persisted in, however, digestive disturbances are almost sure to arise, and, under such circumstances, the glycosuria will reappear. Professor Bufalini, of Siena, has found that the tolerance of a strictly albuminous diet becomes much greater if thymol be coincidently administered. The good effect of this drug in such cases is solely through its well known action as an intestinal antiseptic. Bufalini believes thymol to be not only useful but necessary in cases of diabetics placed upon an exclusively proteid diet. There may be other intestinal antiseptics the use of which is indicated in diabetes, but there is none, in the opinion of Bufalini, equal to thymol. When albuminuria coexists with diabetes, an exclusive meat diet cannot be persisted in under such circumstances; the diet should be largely or exclusively composed of milk and buttermilk. There are different opinions as to the use of milk in uncomplicated diabetes, but when this disease coexists with chronic nephritis, the least injurious food is undoubtedly milk.

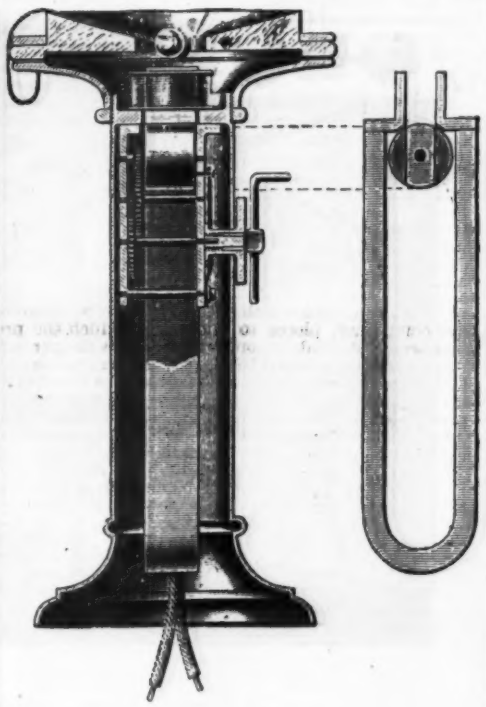
There is an undoubted relation between gout and diabetes mellitus, and when the patient afflicted with the latter is of gouty diathesis, good results will follow an alkaline treatment. The alkaline lactates, recommended by Cantani, the salicylates, or the carbonates may be used alternately.

Opium is a drug of undoubted efficacy in this disease, and one for which there is a remarkable tolerance. It is not only of negative benefit by obtunding the senses of thirst and hunger, but it seems to have a positive effect in diminishing the excretion of sugar.

To resume, the alkalies, opium, and intestinal antiseptics (above all, thymol) are the only drugs upon which reliance should be placed in the treatment of diabetes mellitus, and these are subordinate to a strictly proteid diet.—*Therapeutic Gazette.*

SIEMENS' TELEPHONE SIREN.

THIS instrument, which is shown by the figure, consists of the well known Siemens' bipolar telephone, with the addition of a special hand-worked arrangement for calling. The latter consists of two diametrically opposed segments of soft iron, forming part of a brass cylinder, which the operator can rapidly rotate by means of a small crank handle turning a train of wheels, gearing with the armature. This rotation causes a rapid introduction and removal of the armature from the magnetic field below the soft iron pole pieces and a corresponding magnetic change in



their cores, which affects the home as well as the distant telephone diaphragms, setting them both into vibration. In general the siren-like sound emitted by the telephone alone is quite sufficient for the purpose of a telephone call; but the small bullet which is attached to the cord may be kept resting on the diaphragm; it is brought into violent movement by the vibration of the latter, and acts as an intensifier of the telephonic sound emitted.

The armature, if left to itself, would take up a position across the field below the poles, and weaken the magnetic field through the diaphragm. In order to avoid this, when the telephone is used for conversation, it is necessary that the armature be always brought into its neutral position and locked there. This is done by a special spring-catch, dropping a pin into a pin-hole, which arrests the armature in the proper position.

When a call is given, this pin is first drawn out of action by a cam with a milled head, which, together with the crank-handle for rotating the armature, project outside the telephone casing.—*Electrical Review.*

THE TESLA LECTURE IN ST. LOUIS.

THE Tesla lecture was a notable feature of the recent National Electric Light Convention, St. Louis. At first it had been proposed to deliver the lecture in a small hall, but the demand for tickets was so enormous that it was decided, as a matter of sheer necessity, to secure a larger auditorium, and this was found in the Exhibition Theater, which seats about 4,000 people. It was, of course, practically impossible that all could hear and see, but those who were there could at least say they had seen Mr. Tesla afar off and witnessed some of his most striking experiments. The hall was crowded to suffocation, and the demand for tickets was so great that they were selling briskly for three and five dollars on the steps of the hall. Under such circumstances Mr. Tesla contented himself wisely with showing some of the more "spectacular" of his experiments, and even these were followed at a disadvantage in view of the immense distance from which most of the spectators studied them. After his introduction by Mr. Ayer, the lecturer gave a few minutes to a statement of the conditions involved in his work, and then, by means of his high frequency and high voltage currents, aided by disruptive discharge from a condenser through an induction coil, as well as by direct dynamic phenomena, he produced a number of the interesting results that have already made his name famous and have charmed two worlds. He received, unhurt, currents of hundreds of thousands of volts, lit up tubes and lamps through his body, rendered insulated wires several feet long entirely luminous, showed a motor running under the influence of these million-frequency currents, obtained a number of effects with phosphorescent lamps, and also showed how little in such work the high resistance of the filament had to do with the lighting up of ordinary 50 or 110 volt lamps. His ability to produce such effects, either with a single wire and no return, or without any wires at all, aroused the utmost interest and enthusiasm, and the concluding demonstration literally brought down the house when he showed how, by simply carrying lamps or tubes into a room or hall where those currents were being developed, illumination was the immediate result.

In his opening remarks, Mr. Tesla enlarged upon the grandeur of nature, and expressed his opinion that the most wonderful of the external influences that affect us is light. Hence it followed that the most wonderful and important of the organs by which these external influences beat in upon us is the eye. Two facts were specially referred to, one of them being that the eye is the only organ capable of being affected directly by the vibrations of the ether. Another fact was that the eye would be able to distinguish objects at almost any distance, were it not for the minute particles and stray gases filling the intervening space. These absorb the energies of the ether vibrations, but in a pure medium they would travel unchecked, and the range of vision would be infinitely greater. Mr. Tesla then alluded to the importance of the part played by the eye in furnishing the race with its ideas and knowledge, and to its vital function in controlling all our motions and actions. From its teaching were derived consciousness, ideas, conceptions that were impossible without images—and images involved sight.

By these interesting stages Mr. Tesla led up to the subject of light and thence to the part of electricity in giving us light. The general aim of the discourse was to show and explain the phenomena due to electrostatic forces, followed by phenomena produced by electro-dynamic agencies; and then, as a third class, the light effects, Mr. Tesla's idea evidently being to give a generalization of these phenomena, and of their relations. It was stated, parenthetically, with regard to the physiological effects produced with the high tension, high frequency currents employed, that a great amount of energy may be sent into the body of a person by their means, merely because the energy was dissipated laterally from the body and was not passed through the body in the direct manner involved in the use of a low frequency current. It was due to this intense rapidity of vibration that the lecturer was able to receive with impunity currents of as high as 250,000 and 300,000 volts, and of an amount which otherwise administered would kill. The lecturer explained that he had so arranged his apparatus that in case of any failure of any part of it, the current would kindly abstain from killing him, and would only knock him down.

Many of the experiments shown have already been seen either in this country or in Europe, yet there were several novel effects introduced, and even the familiar experiments were performed with apparatus different from that used before. In most of the experiments the ordinary alternating and continuous currents from the central station were used, although Mr. Tesla also had his own special generator running in the basement.

A striking new experiment was to show at the beginning of the lecture the effect of a varying electrostatic stress through the dielectric. This experiment was performed by grasping one terminal of the high tension transformer giving about 200,000 volts pressure, and approaching the other hand to the opposite terminal. Streams of violet light then issued from the fingers and the whole hand. (At the lecture on the preceding Friday at the Franklin Institute in Philadelphia, Prof. Houston noticed these streams of light coming also from the lecturer's back, following roughly the line of the vertebral column.)

Another experiment was performed showing the action of the air between two condenser plates. By attaching these plates to the high-tension transformer, the whole space between these plates was filled with light, the distance apart being about ten inches. It was pointed out that these streamers consumed considerable energy and developed abundantly ozone and nitrous acid, and it followed that it was necessary to exclude air from high-tension apparatus.

The action of the air was shown in another very striking experiment. Two incandescent lamps exactly alike, one exhausted, the other not, both of the ordinary 50 volt type, were attached in multiple arc, and a current vibrating about one million times a second or thereabout was passed through the filament. It was demonstrated that the lamp which was exhausted glowed brightly, whereas the other one in which the filament was surrounded by air, at ordinary pressure, did not glow. Yet the latter lamp got hotter than the other. This showed the great importance of the rarefied gas in the heating of a conductor, and it was pointed out that in incandescent lighting a high resistance filament does not at all constitute the really essential element of illumination along these lines. Also that heavy blocks of metal may be brought to incandescence by minute currents, provided they are surrounded by rarefied gas, and provided the potential and frequency of the currents is sufficiently high.

One of the most interesting experiments was the conversion on open circuit. A transformer was taken and the current passed through the high tension, winding in such a way that only one terminal was attached to the source of the rapidly alternating current. In spite of this, there was a current passing through the primary, as though the other terminal were actually attached to the source like an ordinary return circuit. This open circuit transformer contained a secondary low tension winding, and the minute currents

passing through the primary were transformed into currents capable of following the ordinary electric wire and lighting up brilliantly an ordinary lamp. It was pointed out that, under certain conditions, indeed, such a conversion was quite practicable, and that it can be practiced with high economy. It was further pointed out that any kind of device, such as motors, etc., may be operated in this manner, with one wire or circuit only.

Mr. Tesla in the course of his lecture dwelt upon his method of conversion by means of disruptive discharges from continuous or alternating station supply. There were two kinds of apparatus on the stage, one operated from the alternating circuit and the other from the regular direct current system. A peculiar form of discharger was used contained in a mica-lined wooden box. The spark-gap was warmed by a small lamp underneath, for the purpose of making the air dielectrically weak. This enabled Mr. Tesla to work with a very long gap, a very sensitive arc, and a comparatively small electromotive force in the gap. The effects obtained were thus augmented very materially. It was pointed out that with this method of conversion there is no difficulty whatever in obtaining sparks of any length. It becomes simply a question of the energy supplied, through what distance the spark will be visible. During the lecture, lamps were operated by this method of conversion. An ordinary 100 volt, a 50 volt and a two volt lamp were brought up to full candle-power with equal facility. Then a little motor was run by means of these disruptive discharges, it being a phase-motor comprising simply an iron core with a closed secondary coil in it, and a disk armature arranged to rotate above the core. Mr. Tesla remarked rather *naively* that if the demonstration were not quite equal to the expectation, the long-continued and weary work on the development of the invention, besides the inability of the experimenter, might be the cause. He went on, in connection with this, to refer to the transmission of power from Niagara, and gracefully recognized the presence on the platform of Prof. George Forbes, who is so prominently identified with this great work. Mr. Tesla believed that we were about to see such great powers transmitted long distances and over one wire.

Continuing, Mr. Tesla remarked that he had shown things of a more spectacular nature with reluctance, yet forced thereto by the desire to gratify those who had shown their interest and formed so large an audience. A number of experiments were performed not seen in this country before, though some had been shown in England. For instance, a phosphorescent bulb was lighted up by being merely held in the hand, and this was a most successful experiment. Mr. Tesla prefaced it by relating a little anecdote of Lord Rayleigh. When he was in London, remarked Mr. Tesla, with much feeling, he had the pleasure of performing this experiment privately before Lord Rayleigh, and he would always remember the trembling eagerness and excitement with which that distinguished scientist witnessed the lamp light up. The appreciation of such men, said Mr. Tesla, repaid him fully for the pains he had been at in working out these phenomena.

In this experiment a number of tubes were taken and flourished or flashed in various ways, and with the current made intermittent at longer intervals by adjusting the spark-gap. Wonderfully beautiful effects were thus produced, the light of the whirled tube being made to look like the white spokes of a wheel of glowing moonbeams. Then some rectangular tubes were taken and flashed or whirled so as to produce curious designs of luminous lines.

A bulb was shown by Mr. Tesla said by him to be so highly exhausted that when the bulb was merely attached to one terminal of the disruptive discharge coil, it would send the sparks across the outside of the globe to the other terminal, which was on the opposite end, rather than pass through the bulb. The bulb in question was painted on one side with a phosphorescent powder or mixture, and threw a most dazzling light, far beyond that yielded by any ordinary phosphorescence. It was pointed out that there was no difficulty whatever in obtaining powerful phosphorescent effect in this way, and that a practical illuminant on these lines needed merely the perfection of the method of conversion above alluded to.

In conclusion, the lecturer made fine cotton-covered wires stretched on a frame over the table luminous, so that in the dark they looked like attenuated violet caterpillars yards long; and then within a large rectangle formed by such wires he flourished tubes in the interspace, these tubes flashing with light wherever waved.

After the lecture, so great was the desire of the public to see Mr. Tesla closer, an informal reception was held in the lobby, when several hundreds of the leading citizens seized the opportunity and Mr. Tesla's hand in a very vigorous manner.

It should be added that the Electrical Exchange, of St. Louis, presented Mr. Tesla at the beginning of the lecture with a magnificent floral shield, wrought in white carnations with a border of palms and American Beauty roses. It was about four feet in diameter. In the center was a circle of red carnations bordering a tablet of white ones, bearing the letters in red $C = \frac{E}{R}$

Around the circumference were the floral letters: "St. Louis Electrical Exchange, 1893."—*Electrical Engineer.*

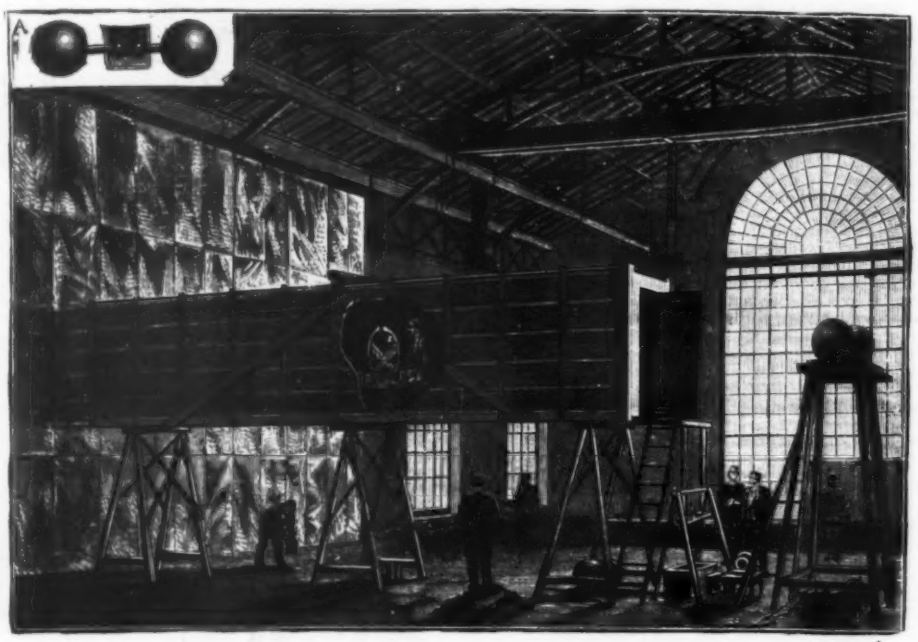
ELECTRIC OSCILLATIONS.

BY one of the grandest scientific syntheses that our age of science has seen appear, the illustrious Maxwell has given irrefutable proofs of the equality of the velocity of light and electrodynamic actions. He concludes therefrom that the two phenomena are propagated by a similar motion of the same medium, ether, and that luminous undulations differ only by their rapidity from the undulations that produce electrodynamic induction. But Maxwell's demonstrations, embodied in delicate formulas, remained but little known outside of the world of professional physicists, and it remained to give a popular and tangible proof of them. This is what has been done by Mr. Hertz, now professor at Bonn, where he has replaced Clausius. The elegant method that he has devised has opened a domain in which many physicists and geometricians have worked and will work again. The Messrs. Sarasin and De la Rive were the first to improve Mr. Hertz's methods, determining the nature of the phenomena upon an important point. Mr. Poincaré, the eminent geometrician, on his part, treated with a masterly hand certain parts of the theory verified by Mr. Bjerknes, a pupil successively of Mr. Poincaré and Mr. Hertz. We may mention among the physicists who have in France treated the experimental question with the most success, Mr. Blondlot, of Nancy, and Mr. Perot, of Marseilles.

Although "comparison is not reason," we can nevertheless obtain an elucidation from a hydraulic representation of the electric phenomena. Two vertical tubes of a water tube level being connected by a wide tube will put themselves in equilibrium through a series of oscillations, if, for any cause whatever, the level of the liquid is changed, while if the tube is constricted the equality in height will be re-established by a slow and asymptotic motion. In the same way, in certain conditions of capacity and efficacious resistance of a system composed of two balls separated by a short interval, an electric discharge passing from one ball to the other will be asymptotic, while in other cases it will be oscillatory.

When the oscillations reach the number of several hundred millions per second, the effects of induction become considerable, and the action, propagating itself with a velocity of 300,000 kilometers per second, produces striæ of tension in space analogous to sonorous waves in the air or in another body. These waves are not propagated in the conductors; they slide upon their surface when they are tangent, or are reflected when they intersect them. Especially are they capable, like sonorous waves, of producing centers and fixed nodes if they return upon themselves.

At the beginning of his researches, Mr. Hertz believed that he had found that the waves, making their way in the wires, had a velocity equal to 0·6 only of that of light. This result, however, he gave merely as provisional and not very certain. This opinion was invalidated by the first experiments of Messrs. Sarasin and De la Rive. But these conscientious and able observers did not stop there. Judging that the insufficient dimensions of their Geneva laboratory might invite criticism, they tore down the partitions, without, however, modifying the result. Finally, at the request of Mr. Hertz himself, they decided to operate upon a larger scale, and carried their apparatus into the turbine room of the motive power works of the Rhone.



GENERAL VIEW OF MESSRS. SARASIN AND DE LA RIVE'S LARGE APPARATUS.

A, details of exterior: the terminal balls are immersed in oil.

The figure that accompanies this article represents the huge installation of these experiments. To the right is seen the exciting apparatus—that which produces the oscillatory spark. The electrodynamic action, propagating itself in all directions, strikes the 8×16 meter mirror at a distance of 15 meters. It returns upon itself, and, upon the depressed perpendicular of the exciter upon the mirror may be observed centers and nodes of oscillation. To this effect it suffices, over this line, to move circles of wire, almost closed and only a very small interval left open. In the nodes of oscillation nothing peculiar is perceived, but in the centers, on the contrary, the induced spark plays continuously between the small balls that limit the interval.

For observing in the dark and more conveniently operating, the experimenters constructed a wooden tunnel in whose axis the phenomenon was verified.

Knowing the internode of the oscillations, we deduce therefrom the length of the wave, which is the double of it. We can, on another hand, calculate the number of oscillations per second that produce an action in the receiving circle, which is analogous to the Helmholtz acoustic resonators and bears the same name. This number, multiplied by the length of the wave measured, gives the velocity of propagation of the electrodynamic actions. This supposes, of course, that in the series of interpretations that we have just given no error of reasoning has been committed—a point upon which all physicists are not agreed.

This stated, Messrs. Sarasin and De la Rive found in their large installation identically the same result that they observed on a small scale: the velocity of propagation of electrodynamic actions in the free air is the same as along wires, that is to say, on their surface and not in their interior, where they are not propagated at all. By the process whose principle we have just briefly sketched, Mr. Blondlot has, moreover, demonstrated in a direct manner that such velocity is equal to that of light.

But the researches do not stop here. The measurement of the velocity of propagation of electric undulations in various media have formed the subject of some labors whose results are very interesting. Mr. Cohn, for example, has found that the velocity in water is 8·5 less than in the air, and this is precisely the value of the index of refraction of water for the electric undulations found by Mr. Ellinger. The square of this number, 72, is very near the value, paradoxical in appearance, found by a large number of observers as the dielectric constant of water. The index of refraction of alcohol, equal to 4·9, leads to the same verification, as the Maxwell theory desires it.

But with optics it is possible to establish other interesting parallels. Our readers remember the admirable experiments that led Mr. Lippmann to fix colors by photography. Light reflected upon a mirror of mercury forms, in the collodion plate, striæ that determine the semi-opacity of a series of equidistant parallel planes. An experiment due to Mr. Hertz, but which Messrs. Sarasin and De la Rive have just performed in proportions that have not been equaled up to the present, is in all respects analogous to that of Mr. Lippmann, and if, with the majority of physicists, we admit that luminous and electric waves differ only in length, the two experiments are identical, the dimensions being in the ratio of 1 to 10,000,000.

Ten years ago only one would not have dared to hope that Maxwell's ideas would, after so brief a delay, receive so brilliant and tangible a confirmation.—*La Nature.*

THE LUNAR SURFACE.

AT the present day the general idea with regard to the peculiar features of the moon is that they are the results of stupendous volcanic actions, the number and activity of which surpassed anything that we can imagine. Owing to the extraordinary circularity in the craters, ring plains, walled plains, and to the well-known fact that many of the craters have not the raised lava floor half way up or near the summit of the cone, which is such a typical terrestrial characteristic, doubt as to their volcanic origin has often been raised. In a small pamphlet which we have received from Mr. S. E. Peal, Sibsagor Assam, the author suggests a "theory of glaciation" in the light of recent discoveries with regard to the maximum surface temperature, and also to the non-viscosity of ice at low temperatures, together with the admitted possibility of snow existing on the moon.

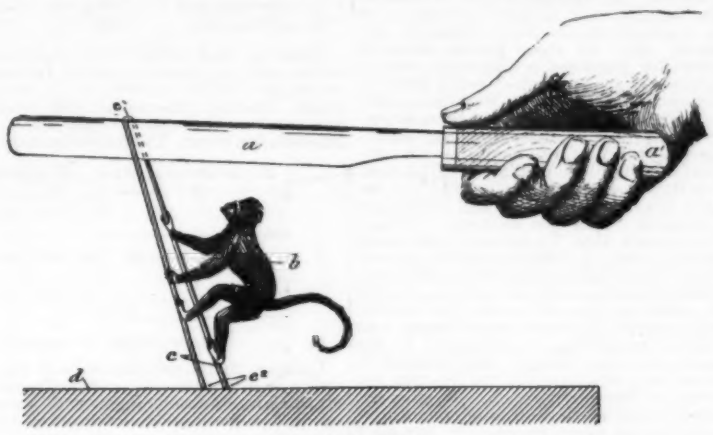
The author assumes the moon to be constituted somewhat like our earth, and at one time to have been at a higher temperature, having an atmosphere, water, etc., and draws attention to the facts that there are no polar caps; that color is conspicuous by its absence, "a feature quite opposed to terrestrial experience, except at the poles," and therefore "may not the entire globe be swathed in snow?" and the absence of river valleys and drainage sculpturing, indicating that a piling up of dry material has taken place in opposition to a fluvial erosion. At the time when the lunar globe had so far cooled down as to be practically rigid, the tidal action would gradually turn all continents and land surfaces into shoals, and at the temperate stage of development the growth of the polar caps would be restricted to the shallows, extending from them as the temperature became reduced.

This advancing sheet of ice would sometimes be deformated by submarine heat vents, resulting in a large or small bay, depending on the magnitude of the vent. Extending seaward the "horns of the bay would meet around and inclose this area of higher mean temperature, converting it into a lagoon." Nocturnal radiation and solar heat alternately would perhaps freeze and thaw the ice formed thereon, and with a rare atmosphere and intense cold aqueous vapor would arise from "the water (floe-covered) floor during the day at least, and be carried over the ice edge by diffusion, when the fall in temperature would precipitate it into snow, thus gradually forming a vast rampart." Century after century would see the level floor gradually lowered, and the ramparts increased in height. The

author accounts for all the peculiar forms of craters, walls, etc., by different local conditions (*i. e.*, land or water or submarine vents), but they are all the result "of water floors left in a slowly extending glaciation of the crust."—*Nature.*

A PATENT TOY.

A TOY of German origin has lately been patented here. It consists of a grotesque figure caused to climb or crawl upward along and toward the highest portion of an inclined plane or straight edge by means of a bent wire to which it clings. The result is accomplished by the invisible and unconscious nervous or muscular vibrations and twitchings of the hand and arm of a person holding the straight edge, so that such person, as well as the spectator, cannot account for the phenomenon of the grotesque figure clinging to the bent wire and traveling up hill by means thereof, without the application of visible traction force.



A NEW TOY.

The parts being in the position illustrated in the drawing, the vibrations of the hand impart an oscillating motion to the blade, *a*, and this motion is imparted to the staple, *c*, and causes the lower ends to slip along the table in the direction of inclination of the staple when the blade is lifted, and its upper portion is caused thereby to slip along the blade in the same direction when the blade is depressed, with the result that the monkey travels toward the high end of the blade, that is, toward the left in the drawing. Of course the rate of travel of the monkey depends upon the degree of trembling or twitching of the hand or arm of the manipulator, and by practice it is possible to acquire the requisite strength and skill for preventing such tremblings and twitchings, whereby the monkey is permitted to remain at rest. Consequently in playing this game, as in playing other games requiring skill and practice in order to attain proficiency, a certain feeling of competition among players and spectators is created.

THE CHATHAM ISLANDS AND AN ANTARCTIC CONTINENT.

AT the last meeting of the Royal Geographical Society Mr. H. O. Forbes discussed the question of the former extension of an Antarctic continent in relation to certain observations made during a recent visit to the Chatham Islands. The whole surface of these islands, especially Wharekauri and Rangiauria, is covered with a bed of peat in places over forty feet in depth—deeper in the northern part than in the southern—traversable in safety only by those acquainted with the country; for to the inexperienced eye there seems in most places no difference in the surface which can carry with safety both horse and rider and that on which the lightest-footed pedestrian cannot venture without being engulfed. The surface of some of the larger and wetter depressions in the ground was covered with a brilliant colored carpet of luxuriant mosses, emitting an aromatic fragrance, spread out in artless undesigned parterres of rich commingled green, yellow, and purple, and endless shades of these, warning the traveler of the existence of dangerous bogs beneath, and brightening miles of treeless moorland, which, but for those floating gardens, would be uninviting and uninteresting. In many places all over the island this great peat moss is on fire, and has for years been smouldering underground, or burning in the exposed faces of the great pits which have now been burnt out. Dr. Dieffenbach mentions these fires at his visit in 1840, and states that the combustion had begun before 1834. They appear to have been burning in one part or another of the island ever since Dieffenbach's visit. A peculiarity in the main island that strikes the visitor very early is the occurrence of many lakes and tarns. These lakes are, for the most part, on the eastern side, at the back of the low hills facing Petre Bay. The largest is fifteen miles long, over forty miles in circumference, and about ten and a half miles broad at its widest part.

Mr. Forbes' object in visiting the islands was to look for the remains of a fossil bird, fragments of which had been sent to him in New Zealand. These he discovered in considerable numbers, and found that the bird was no other than a species of aphanapteryx, a large and remarkable member of the rail family, which lived contemporary with the celebrated dodo in the island of Mauritius, and was very similar to one of the extinct flightless birds of that island. Here was the only place in the world where it was known to exist, and where it had with the dodo preserved its fading race down to about two hundred years ago, when both of them passed away and perished for ever from among living things. In the Chatham Islands the remains of the aphanapteryx were found in kitchen middens of the Morioris, showing that in this region of the world also it had survived down to comparatively recent date, just as the moa had in New Zealand.

In the Chatham Islands there still live several types of flightless birds scarcely represented elsewhere, except in widely separated oceanic islands. To account for their distribution it is necessary to reason backward to former distributions of land and sea. The occurrence of similar forms in the three southern continents and in the islands which lie between them is most easily explained by a former Austral continent of considerable northern extension. The outlines of this continent it is of course impossible to trace with anything approaching to accuracy till we are in possession of a larger number of soundings. But it is not unlikely that the great meridional masses of land—or world ridges—which are probably of primeval antiquity extended to meet prolongations northward of the Antarctic continent. There is some evidence that the direct union of South Africa with the other continents was not for so prolonged a period as the others. The presence of the aphanapteryx and other ocydromine birds both in the Mascarene and in the New Zealand continental islands supports other evidence pointing to an extension of that area south by Marion and Kerguelen Islands, and of New Zealand south, or of the Antarctic land north, by way of the Macquarrie, Auckland, and Antipodes Islands. It is interesting to observe that the great Pacific trough to the east of the longitude of New Zealand extends far south into the Antarctic region.

It is not necessary to suppose that all the southerly extending arms were connected contemporaneously with an Antarctic continent. It is impossible to account for the presence, for instance, of some South American forms in Australia and not in New Zealand; of Mascarene forms in the New Zealand region and not in Australia, or in Africa, or elsewhere, while we are unacquainted with the orography, the rivers and mountain barriers, of the submerged southern continent; and its various commissures may have been open at one time and closed at another. As there are, moreover, abundant evidences of great volcanic action over all the region, in New Zealand, South America, Mascarenia, and the Antarctic Islands, the permutations and combinations of the ups and downs of these lands, the openings and closings of the gates, paths, or stepping stones, are beyond our computation.

The deductions as to an Antarctic continent, made on biological grounds, are supported by the depth of the circumpolar sea, so far as it is known. The sub-marine plateau of the Austral land slopes northward all round the shores of the known lands more gently than is the case along any other coast, and this would seem to indicate that, if elevated, the land would form in great extent a continuation of the three primal ridges of the globe southward, coalesced and spread out round the pole, with, between these arms, the terminations of the great and permanent ocean troughs. How far these hypotheses—which are but a restatement, in great measure, of the investigations and conclusions of many distinguished naturalists, geologists, and geographers—may be substantiated or refuted by future discoveries it is difficult to say; but the discovery of these interesting aphanapteryx bones on the Chatham Islands must always remain an important factor in the solution of this question.—*Nature.*

THE SANDGATE LANDSLIP.

THE great landslip which occurred at Sandgate, England, on Saturday night, March 4, 1893, and early Sunday morning has had all the destructive effects of a severe earthquake, without the sudden terror of the shock. It has ruined the little town for this season at any rate. Nearly two-thirds of the area of the town have been affected, about 130 houses being ruined, besides stables, conservatories, and other out-houses, the ground in some places having sunk as much as eight or nine feet. The disaster seems to have been caused by the percolation of water through the sand, of which the hills at the back of Sandgate are formed, to the clay upon which the houses stand. The subsidence extends for nearly a mile east and west, and the houses in that distance are built in terraces to a distance of about 150 yards from the sea front. The subsoil of these terraces consists of a slippery, loamy clay, very liable to slide if saturated with water, and the heavy rainfall of the last few weeks permeating a soil so treacherous is sufficient to account for the disaster, although it is suggested that the shocks caused by the dynamiting of the wrecked Calypso and the Benvenue may have increased the instability of the ground.

Our illustration, from a photograph, taken immediately after the disaster, will give an idea of the condition of the town, with its dreary rows of ruined houses. Some are totally destroyed, others are so damaged that they are expected to fall every day. Hundreds of inhabitants have been turned out of their homes, and for the lodging house keepers, who form the majority of the population, the landslip means ruin, while many comparatively well-to-do people will suffer severely. Only an approximate estimate can be made of the value of the injured property, but it is feared that it exceeds a hundred thousand pounds.

That the disaster was the result of natural causes alone is the almost unanimous opinion of experts. As these causes are due to the saturation of subterranean sandy strata, from which the water could not escape, it seems obvious, as Sandgate lies fairly high, as the inspector set forth at the inquiry held by the local government board, that a remedy can be found against future accidents of the kind in deep parallel drains emptying into the sea.—*Black and White.*

The London *Times* says: An extraordinary and calamitous disturbance of land began Saturday, March 4, at the little south coast town of Sandgate, near Folkestone. The first disturbance was felt at 7:45 p. m., there being then a rocking motion, which, however, subsided, and with it the alarm it had occasioned. But other disturbances followed, and a number of inhabitants began to get their furniture into the streets. The pavement on each side of the main street was forced up. The sewers from Shorncliffe Camp were dragged apart, and the water and gas mains fractured, some of the latter being bulged up out of the ground to a height of two feet. After the first shock the coastguardsmen were ordered to clear out with their families at once, their houses being in a very dangerous condition. Large houses containing valuable property, whose owners had joined in the general flight, were put under the charge of bodies of soldiers and special police. A further disturbance of the land, possibly worse than the first, took place at five on Sunday morning when the tide receded. Generally speaking, every house is more or less affected between the coastguard station, close to the New Beach Rocks Conva-

SPRING HOUSE, HIGH STREET.—FROM A PHOTOGRAPH.

lescent Home and the military hospital. The line taken by the subsidence is very clearly indicated. Houses have slipped away from each other, leaving gaping sections, others have their walls bulging out and are on the verge of toppling over, while great rifts appear in the ground at every turn. A very remarkable phenomenon has occurred along the foreshore, not far from low-water mark, where there has been a distinct upheaval of sea-bed. During the space of a tide a ridge about four or five feet in height was formed. About two-thirds of the area of Sandgate has been affected, and it is estimated that somewhere about 200 houses have been wrecked, or more or less damaged. The marvel is that no one was either killed or injured. In some parts of the slopes the land has sunk as much as seven, eight or nine feet. The evidence of the disturbance extends across the road which runs along by the seashore, cracks occurring very frequently in the road and across the promenade. There was a great deal of alarm among the convalescents at Beach Rocks Samaritan Home, where there were 130 patients. The water and gas pipes were so broken that at night the town was in darkness, the town crier being sent round to warn the inhabitants where they could obtain candles and lamps, while water was conveyed from house to house by means of water carts. It is estimated that one-half the ratable value of the town has been practically destroyed.

[Continued from SUPPLEMENT, No. 884, page 14122.]

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By PERCY F. FRANKLAND, Ph.D., B.Sc. (Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

LECTURE III.

HAVING now made ourselves acquainted with the important methods of handling micro-organisms which have been developed mainly during the past ten years, we must turn to consider some of the principal results which have been achieved by their means.

It must be noticed, in the first instance, that during the greater part of these ten years, the modern methods of bacteriology have been mainly employed to elucidate problems connected with the cause and communication of disease, and in this department truly astonishing strides have been made. It is only within the latter half of the decade that much serious work has been undertaken in connection with the chemical changes brought about by micro-organisms, but there can be no doubt that this side of bacteriology will annually absorb more and more attention, as the problems involved are really of more fundamental importance, although not invested with so much sensational interest.

There can be no doubt that the investigations of a practical character, in which these recent bacteriological methods have been utilized, which have attracted most attention are those of Christian Hansen, whose name is so familiar throughout the brewing world. I do not propose entering into a description of his researches, which have been very comprehensively dealt with here in a course of Cantor lectures by Mr. Gordon Salamon, in the year 1888. We may, however, summarize the work of Hansen by saying that while Pasteur showed the advantages of brewing with yeast free from other micro-organisms, Hansen has further industrially demonstrated what Pasteur had also indicated, viz., the advantages of brewing with particular species or varieties of yeast. As far as this country is concerned, however, Hansen's researches have hitherto been of little more than theoretical interest; scientific men and brewers have made themselves acquainted with his results, and in some cases have conducted laboratory experiments on the same lines, but in hardly a single instance, as far as I am aware, have his methods been introduced or adopted on a large scale.

But, although Hansen's methods have gained no footing in this country, it must not be supposed that they have undergone no further development; on the contrary, we learn that his pure yeasts have been adopted in bottom fermentation breweries in all parts of the world, and even in top fermentation breweries they have been used with great success in Denmark, Belgium, France, and Australia. Of great theoretical interest are some recent researches of Hansen's which open out great possibilities in the future. In these investigations he has found that it is possible to produce artificial varieties of yeast, the acquired properties being transmitted from one generation to another, apparently indefinitely; it is obvious that we have here the beginnings, on a microscopic scale, of practices which have long been carried out on the higher plants in floriculture.

The production of more or less permanent varieties of other micro-organisms than yeasts is also attracting much attention at the present time, and is throwing much light on the subject of heredity and evolution.

A striking instance of variation has recently come under my observation in connection with a bacillus which has the property of fermenting calcium citrate. This power it has continued to exercise for years, but if it is plate cultivated, and one of the colonies then introduced into a solution of calcium citrate, I find that the latter is never fermented, the bacillus having lost its fermenting power through cultivation in the gelatin medium. If, however, one of the colonies in question is put into a broth solution of calcium citrate, the latter is fermented, and on then passing the bacillus from this to the calcium citrate solution, which it before failed to act upon, it now sets up fermentation in this also.

Perfectly similar phenomena are also frequently observed in the case of pigment-forming bacteria; the power of producing the particular pigment may be permanently lost unless some special treatment is resorted to in order to restore the power. One of the most striking instances of this kind is that of the well known *bacillus prodigiosus*, which produces a magnificent crimson pigment, the power of producing which becomes, however, gradually lost if it is continuously cultivated on gelatin or agar, and immediately restored if the organism is transplanted to potatoes.

This possibility of producing more or less permanent varieties of micro-organisms has greatly complicated the problems of bacteriology, and shows how very far we still are from having any sound basis on which to establish distinct species. The construction of species was first attempted on a morphological basis, difference of form being made the dominant principle. It is unnecessary for me to remind you how completely this artificial morphological classification has collapsed. The classification has been attempted on physiological lines, but this has proved equally untenable, for a given organism may be made to entirely modify some of its most striking physiological characters. Thus, a fermenting organism, as I have shown, may be made to lose its fermenting power—a pathogenic form may be deprived of its sting, so to speak, and lose its virulence either temporarily or permanently. Again, the construction of species has sometimes been attempted on culture characteristics, such as the liquefaction or non-liquefaction of gelatin, production of pigments, appearance of colonies, etc. All these points, although extremely valuable for purposes of diagnosis, cannot be applied so rigidly as to warrant their being used for the purpose of absolute classification. Perhaps a point which has been more implicitly belived in than almost any other, for the purpose of distinguishing micro-organisms, is their property of producing or not producing spores under prescribed conditions. This test, however, entirely breaks down by the light of the extremely important discovery by Roux and Chamberland of what is called "sporeless anthrax." These investigators have shown that, by suitably cultivating the anthrax bacilli in media to which a small amount of an antiseptic has been added, a race of bacilli is obtained which differ from the ordinary anthrax bacilli in being unable, under any known conditions, to form spores. This asporogenic character is permanent, and is maintained even though they be cultivated on the most diverse media, aye even though they be made to pass through the system of an animal, for they are not in any way attenuated, but fully virulent. We must not hesitate to confess, therefore, that although our knowledge of micro-organisms has so enormously increased within recent years, we are still destitute of any foundation on which to establish a differentiation into species. It is, moreover, precisely this instability of properties, and the comparative facility with which they can be moulded at the will of the experimenter, that renders the study of micro-organisms so fascinating and attractive.

FIG. 17.—SPORELESS ANTHRAX BACILLI.

A point of great interest in connection with the introduction of pure yeast fermentations is the influence of the pure yeasts on the formation of the well known by-products—glycerin, succinic acid, and higher alcohols. There was a very general impression in some quarters that the higher alcohols were due to fermentations induced by extraneous yeasts, and that each particular yeast, if employed in a pure state for fermentation, would give rise to only one alcohol. This matter has as yet been but very imperfectly investigated, but, from some recent experiments of Perdrix, it appears very probable that the amyl alcohol, which is such a constant product of the fermentation of potato mashes, may be the result of a subsidiary fermentation set up by anaerobic bacteria, which are specially favored by the presence of starch.

There is also some evidence that the formation of higher alcohols is, to a certain extent, dependent on the temperature of fermentation. Thus, Lindet has found that there is a somewhat larger proportion of higher alcohols produced in fermentations carried on at a high than at a low temperature, thus using the same mixture of top and bottom yeasts; in each case the following results were obtained:

Temperature of Fermentation.	Crude Alcohol.	Higher Alcohols	
Deg. C.	c. c.	c. c.	Per cent.
32–35	675	3·9	·58
25–27	1607	9·6	·59
19–21	1834	9·9	·54
8–10	1877	9·7	·52

It is much to be regretted that these experiments were not made with pure yeasts, as the interest attaching to them would have been very much greater.

In the matter of glycerin production, it also appears, from Borgmann's experiments, that less of this material in proportion to the alcohol is formed when pure yeasts than when the ordinary mixed yeasts are used. Thus:

	Ordinary Lager beers.		Beers produced with Carlsberg.	
	Max	Min.	No. 1 yeast.	No. 2 yeast.
Alcohol : Glycerin....	100 : 3·497	100 : 4·140	100 : 2·63	100 : 3·24

As regards the theory of the alcoholic fermentation, it must be admitted that we are still very much in the dark, especially as Pasteur's original explanation of the fermentation phenomena being due to yeast life, in the absence of oxygen, is not borne out by recent experiments. For, not only has it been shown that the same changes take place when the yeast is grown with abundant access of oxygen, but the quantity of the fermentation products is actually greater than when oxygen is excluded. In defense of Pasteur's theory, this has generally been accounted for by assuming that the presence of oxygen increases the proliferation of the yeast, and that the larger number of yeast cells then give rise to a larger quantity of fermentation products than do the smaller number of yeast cells which are present when oxygen is excluded. Some very interesting experiments have recently been instituted by Mr. Adrian Brown, which go very far toward undermining this ingenious explanation.

In these experiments Mr. Brown has estimated the quantity of yeast, both by counting the number of cells with the haematimeter and also by actually weighing its amount. He conducted his experiments in such a manner that the number of yeast cells could not multiply during the fermentation, thus avoiding this complicating factor; and in all cases he found that there was more alcohol produced when oxygen was abundantly supplied than when it was excluded from the yeast. Thus—

No Multiplication of Yeast Cells.

(*a.*) Air excluded .... 3·35 grms. alcohol in 120 c. c.
(*b.*) Air supplied..... 3·56 " " "

Thinking that, in the above experiment, the fermentation of (*b*) had been promoted through the agitation occasioned by the current of air passed through the liquid, another experiment was made, in which air was bubbled through the one portion and hydrogen through the other. The following result was obtained:

NO MULTIPLICATION OF YEAST CELLS.

	I.	II.	III.	
(*a.*) Stream of Hydrogen ...	6·20	4·88	2·26	grms. dextrose decomposed.
(*b.*) " Air	7·38	5·289	2·43	" "

LONGEVITY OF YEASTS.

I may at this stage opportunely refer to some interesting results which have recently been obtained by M. Duclaux on the longevity of yeasts. M. Duclaux has had the unique opportunity of examining a number of the yeast cultures which were employed by Pasteur in his "Etudes sur la Biere," in the years 1873 and 1874, and he has not only determined whether these cultures still contained living yeast cells, but also the proportion of alcohol, acid, etc., present in each, from which it is possible to draw conclusions as to the conditions which favor or militate against the preservation of yeast life. His results are summarized in the table, opposite.

From the table it will be seen that age alone has had little or no effect in causing the death of the yeasts; for, of the six deaths, one actually occurred in the youngest culture, which was 11 years old, while the yeast in the oldest culture—17 years—was still alive. The principal cause which accelerates the death of the yeast appears to be the acidity of the medium, and in all the dead cultures a considerable proportion of free acid was discovered, while in most, also, the amount of alcohol was particularly high.

The longevity of yeasts is of special importance in connection with the preservation of pure cultures of yeasts. It has been found by Hansen and Jorgensen that pure yeasts are best preserved in a 10 per cent. solution of cane sugar in distilled water. In such a solution the specific properties of the yeast remain unimpaired for years, while, if the yeast is preserved in wort-gelatin, its properties frequently undergo very serious alteration. I have also myself found that bacterial ferments are very liable to lose, more or less completely, their fermentative power by continuous cultivation in a solid medium like gelatin; and sometimes this power is lost even by a single plate cultivation; and this is a point which all engaged in the study of fermentation phenomena should carefully bear in mind.

BEHAVIOR OF YEASTS UNDER THE INFLUENCE OF HEAT.

In connection with the remarkable vitality of yeasts, I may also refer to their behavior under the influence of heat, as this has been recently made the subject of special investigation by Kayser. This investigation is the more welcome, as the previous information relating to this point is full of discrepancies and contradictions.

Kayser's experiments were made with a number of well-known yeasts in a state of purity, their resistance to heat being determined, both in the moist and dry condition, as well as in the form of spores. The results are summarized in the following tables: in all cases the temperature indicated was maintained for a period of five minutes:

ACTION OF HEAT ON YEASTS AND THEIR SPORES.

(*a*) *In the Moist State.*

	45° C.	50° C.	55° C.	60° C.	65° C.
YEASTS.					
Bass.....	L L	L L	L L	L L	D D
St. Emilion ..	L L	L L	L L	D D	D D
Augustinerbräu.	L L	L D	D D	D D	D D
Holbräu	L L	L L	D D	D D	D D
Spatenbräu	L L	L L	D D	D D	D D
Neunkirchen ..	L L	L L	L L	L L	D D
Sacch. Pastorianus	L L	L D	D D	D D	D D
SPORES.					
Bass.....	L L	L L	L L	L L	L D
St. Emilion ..	L L	L L	L L	L L	D D
Augustinerbräu.	L L	L L	L L	L L	D D
Spatenbräu	L L	L L	L L	D D	D D
Sacch. Pastor. .	L L	L L	L L	D D	D D

N. B.—L = living, D = dead; two experiments were made at each temperature.

The principal points brought out by this table are first that the low fermentation yeasts are mostly more susceptible to heat than the high fermentation forms, and, secondly, that although the resistance of the spores is greater than that of the vegetative cells, yet the difference in this respect is far smaller than that

PARTS PER 1,000 C. C.

No.	Age in years.	Living = L Dead = D	Liquid. B = beer L = acid liquid.	Alcohol (c.c.)	Maltose. (grms.)	Extract. (grms.)	Acetic Acid. (grms.)	Valeric acid. (grms.)	Total Acids (grms.)
1	17		B	31·1	47·0	48·0	0·064	0·114	—
2	15·5		B	2·2	11·0	34·0	0·133	0·470	—
3	,,		B	3·0	—	58·0	0·163	0·427	—
4	,,		B	0·9	—	—	—	—	—
5	,,	L	B	—	—	—	—	—	—
6	,,		B	—	—	—	—	—	—
7	,,		L	—	—	—	—	—	—
8	,,		B	4·0	11·8	33·8	—	—	—
9	,,		B	—	—	—	—	—	—
10	,,		B	—	—	—	—	—	—
11	15·25	D	L	56·0	0·0	10·3	0·450	0	2·40
12	,,		L	—	—	—	—	—	—
13	15·75		B	—	—	—	—	—	—
14	,,	L	B	—	—	—	—	—	—
15	15		B	—	—	—	—	—	—
16	15·5		B	—	—	—	—	—	—
17	,,		L	46·0	11·4	—	1·500	0	3·96
18	,,	D	B	25·8	—	77·2	1·810	0	3·36
19	15		L	1·3	0·5	16·5	0·070	0	4·50
20	,,	L	B	21·5	—	20·0	—	—	—
21	11		B	2·0	—	21·7	—	—	1·15
22	,,	D	B	54·0	20·0	72·0	0·240	0	1·72
23	15		B	—	—	—	—	—	—
24	,,	L	L	5·0	1·0	7·0	0·094	0·028	1·92
25	16		B	30·4	6·0	42·0	—	—	—
26	14·5		B	—	—	—	—	—	—

which generally subsists between bacilli and their spores.

ACTION OF HEAT ON YEASTS AND THEIR SPORES.

(b.) In the Dry State.

	Temperature necessary to destroy.	
	Yeasts.	Spores.
	deg. C.	deg. C.
Bass	95—105	115—125
St. Emilion	105—110	125
Augustinerbräu	—	115—120
Hofbräu	85—90	—
Spartenbräu	100—105	115
Sacch. Pastorianus	100—105	115

The Augustiner yeast is so delicate that it does not stand the slightest heating in the dry state, in fact, it sometimes perishes during desiccation, even at the ordinary temperature of the air. The hardiest form in the dry state was the yeast of St. Emilion, which is a high fermentation variety obtained from wine.

In some cases, the remarkable phenomenon was observed that the progeny of spores, which had resisted a high temperature, was endowed with the power of withstanding a temperature higher than was normal to the particular variety, thus affording evidence of the transmission of hereditary characters, which, as we have already seen, is such an important element in the case of these low forms, as well as with more highly organized forms of life.

CARBOHYDRATES FERMENTABLE BY YEASTS.

Much attention has from time to time been bestowed on ascertaining what carbohydrates are fermentable by yeasts, and great differences of opinion have frequently existed as to this point. Before it was possible to command pure cultures of yeast, the matter could not be investigated with any degree of precision, for ordinary yeast may contain numerous other organisms which, on the one hand, may transform some unfermentable carbohydrates into fermentable ones, while these other micro-organisms may themselves give rise to alcoholic fermentations which may be confounded with the alcoholic fermentation of yeast. The older observers thus frequently record as fermentable by yeast substances which more recent, refined, and accurate experiments have shown to be unaffected by it when presented to them in a pure state. Until recently, it was generally recognized that the carbohydrates fermentable by yeast were dextrose, lævulose, maltose, and cane sugar (after inversion by the yeast itself), while opinion was much divided as to the fermentability of galactose. Recent experiments by Duclaux, Adametz, and Kayser have, however, shown that, although milk sugar is not fermentable by the ordinary yeasts, there do exist one or more forms of yeast which have the power of setting up alcoholic fermentation in this carbohydrate. These milk sugar yeasts, as we may call them, were obtained from a dairy in which much trouble had arisen through the fermentation of the milk. The action of these yeasts on various kinds of sugar has been compared with that of ordinary high fermentation brewers' yeast, and some very interesting differences between them have been brought to light. For not only have these milk yeasts the unique property of fermenting milk sugar, but they are also far more effective than brewers' yeast in fermenting galactose, while, on the other hand, they are much inferior to brewers' yeast in bringing about the decomposition of maltose. The results shown in table were obtained by Kayser.

In consequence of these new yeasts giving rise to a pure alcoholic fermentation of milk sugar, it has naturally been suggested that by means of them a sparkling and highly nutritious alcoholic beverage might be prepared on a large scale from the whey which occurs as such an abundant by-product in the manufacture of cheese. The following figures show the composition of such whey wine, as it may be designated, and which is said to resemble cider in flavor. To increase the alcoholic strength cane sugar was added to the whey before fermentation; while on another occasion the expedient of concentrating the whey before fermentation was adopted: the latter method was, however, not found promising, as the taste was thereby rendered somewhat too saline:

	Whey and Sugar.		Whey (concentrated).
	Yeast c.	Yeast c. + (Saccharomyces apiculatus)	Yeast c.
	per cent.	per cent.	per cent.
Residual Sugar	2·93	1·17	2·37
Alcohol, by weight	2·83	3·68	3·00
Acidity	·24	·15	·60

The possible extent of such an industry may be gathered from the recent statistics prepared by Rew, and which show that 224 millions of gallons of milk are annually used in the United Kingdom for the manufacture of cheese.

This fermented whey is, of course, an entirely different product from koumiss, which is the result of several concurrent fermentations in the milk; in all probability a lactic fermentation at the outset being followed by an alcoholic one subsequently.

FERMENTATION OF ARTIFICIAL SUGARS.

The question of the fermentation of different sugars by yeast has acquired a particular importance and interest since the magnificent achievement of the preparation of artificial sugars by Emil Fischer. These researches are not only of profound interest from a purely chemical point of view, but also in their relationship to fermentation phenomena, and the light which they have thrown on the constitution of the several forms of sugar. Not only has Fischer succeeded in artificially preparing the two most important natural sugars, viz., dextrose and lævulose, but he has also produced in the laboratory sugars which either do not exist in nature or at any rate have not yet been discovered there. He has indeed excelled nature in the production of sugars, for while no natural sugar of the glucose type contains more than 6 atoms of carbon, Fischer has synthesized sugars containing 7, 8, and 9 atoms of carbons respectively. It would be beyond the scope of these lectures to detail the beautiful and ingenious methods by which these bodies have been built up, but the matter is of so much importance to all interested in fermentation questions that I feel constrained to review them very briefly.

The mere production of a sugar of the glucose type is not a matter of any great difficulty. It can be accomplished in essentially the same way as alcohol is converted into aldehyde, *i. e.*, by oxidation.

$$\underset{\text{(Alcohol)}}{C_2H_6O} + \underset{\text{(Oxygen)}}{O} = \underset{\text{(Aldehyde)}}{C_2H_4O} + \underset{\text{(Water)}}{H_2O}$$

If, instead of taking ordinary alcohol, we take glycerin, and submit this to oxidation, we obtain a true sugar, capable of being fermented by yeast, and exerting the well known reducing action on Fehling solution:

[Experiment.—Dissolve 10 grammes glycerin and 85 grammes soda crystals in 60 grammes warm water, cool down to temperature of room, and then add 15 grammes bromine. Shake: the bromine dissolves, and carbonic anhydride is evolved; the reaction is only complete in half an hour, but already after two minutes the production of glycerose can be demonstrated. Take a portion of the liquid, decolorize with sulphurous acid, add excess of caustic soda, then heat with Fehling solution, the characteristic reduction of which at once takes place.]

The sugar thus obtained in an impure form contains only three atoms of carbon, and may be called glycerose $C_3H_6O_3$.

This triatomic sugar passes, however, spontaneously into a true hexatomic glucose: $2C_3H_6O_3 = C_6H_{12}O_6$.

This hexatomic sugar is the starting point in the artificial preparation of the true sugars; the name of *acrose* has been given to it; and it is inactive toward polarized light. Before tracing its metamorphoses further, we must glance at a reaction which has proved of inestimable value in all investigations connected with the sugars, and has already taken its place beside Fehling's solution and the polarimeter in the sugar laboratory. I refer to the reaction between the sugars and the substance known as phenylhydrazine.

This substance readily enters into combination with divers sugars, forming compounds which can be easily purified, and which are particularly serviceable in the identification of different sugars. This substance, phenylhydrazine, may indeed be designated the Rosetta-stone of the sugars, having led, in the hands of Fischer, to the elucidation of the sugar group, even as the famous stone led to the deciphering of the hieroglyphics in the hands of Egyptologists.

[Experiment.—Take solution of dextrose, add solution of phenylhydrazine hydrochloride, and sodium acetate, warm on water bath, yellow precipitate of glucosazone.]

The following table exhibits the value for purposes of diagnosis of these compounds:

	Melting point in Degrees C.	
Glucosazone	205	lævorotary in glacial acetic acid.
Galactosazone	193	inactive in glacial acetic acid.
Sorbinosazone	164	inactive in glacial acetic acid.
Lactosazone	200	inactive in glacial acetic acid.
Maltosazone	206	inactive in glacial acetic acid.
Arbinosazone	160	inactive in alcoholic solution.
Xylosazone	160	lævorotary in alcoholic solution.
Rhamnosazone	180	lævorotary in alcoholic solution.
Gulosazone	156	lævorotary in alcoholic solution.

But not only are these osazones of such importance in the diagnosis of sugars, but they have also been invaluable in the artificial synthesis of these bodies in consequence of the remarkable transformation which they undergo on treatment with strong hydrochloric acid. Thus:

$$\underset{\text{(Glucosazone.)}}{C_6H_{10}O_4(NH.C_6H_5)_2} + 2H_2O = \underset{\text{(Water.)}}{}$$

$$\underset{\text{(Glucosone.)}}{C_6H_{10}O_6} + 2\underset{\text{(Phenylhydrazine.)}}{C_6H_5N_2H_3}$$

Sugars		Grms. per 1,000 c.c. Sugar residual.	Sugar fermented.	Yeast produced.	Acidity.
Milk-sugar 60·30 grms.	a*	25·60	34·70	·510	1·520
	b	25·60	34·70	·270	1·050
	c	21·40	38·90	·450	1·790
Galactose, 36·80 grms.	a	16·80	20·00	·315	1·770
	b	1·67	35·13	·480	1·100
	c	15·84	20·96	·270	1·280
	m	20·80	16·00	·370	·790
Glucose, 37·3 grms., initial acidity = ·180.	a	2·34	34·96	·590	2·030
	b	·00	37·30	·215	1·370
	c	·00	37·30	·485	1·740
Invert sugar, 56·80 grms.	a	2·22	54·58	·413	—
	b	3·25	53·55	·240	—
	c	2·79	54·01	·270	—
Maltose, 89·3 grms., initial acidity = ·600.	a	73·76	24·54	·575	1·425
	b	73·12	25·18	·395	1·480
	c	74·40	23·90	·475	1·280
	m	6·84	91·46	·735	1·830

*a = Milk-sugar yeast of Adametz; b = Ditto, of Duclaux: c = Ditto, of Kayser.

m = Brewers' yeast.

Acidity is expressed in terms of lactic acid.

α-ACROSE (from Glycerose)
i-Glucosazone (by union of α-Acrose with phenylhydrazine)
i-Glucosone (by action of strong hydrochloric acid on i-Glucosazone)
i-Fructose (by action of nascent hydrogen on i-Glucosone)
(by fermentation of i-Fructose with brewers' yeast)
l-Fructose
(dextro-rotary)
i-Mannite (by action of nascent hydrogen on i-Fructose)
i-Mannose (by oxidation of i-Mannite)
i-Mannonic acid (by further oxidation of i-Mannose)
(by crystallisation of strychnine salt this decomposes into)
l-Gluconic acid (by heating l-mannonic acid with quinoline)
l-Glucose (by reduction of l-gluconic acid with nascent hydrogen)
l-Mannonic acid.
d-Mannonic acid.
d-Mannose (by reduction of d-Mannonic acid with nascent hydrogen)
d-Glucosazone (by union of d-Mannose with phenylhydrazine)
d-Glucosone (by action of strong hydrochloric acid on d-Glucosazone)
d-Fructose (by action of nascent hydrogen on d-glucosone)
Lævulose (lævo-rotary)
d-Gluconic acid (by heating d-Mannonic acid with quinoline)
d-Glucose (by reduction of d-Gluconic acid with nascent hydrogen)

The glucosone on treatment with nascent hydrogen yields a sugar of the lævulose type:

$$\underset{\text{(Glucosone.)}}{C_6H_{10}O_6} + \underset{\text{(Hydrogen.)}}{H_2} = \underset{\text{(Glucose of lævulose type.)}}{C_6H_{12}O_6}$$

Equipped with a knowledge of these changes, we can now attempt to study the table above, which indicates the several steps which have led to the artificial preparation of the well known sugars, dextrose and lævulose.

The beautiful symmetry of this series of reactions cannot fail to appeal to all, but no one excepting the chemist can adequately appreciate and admire the marvelous ingenuity of the design and the brilliant experimental skill demanded for its execution and accomplishment.

We now not only understand the chemical difference between dextrose and lævulose, which had previously been explained by Kiliani's formulæ;

$CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHO.$
Dextrose.

$CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CO.\ CH_2OH.$
Lævulose.

But we have through Fischer's researches been supplied with the true optical isomer of dextrose, *i. e.*, a lævorotary glucose, as well as the optical isomer of lævulose, *i. e.*, dextro-rotary lævulose.

This dextro-rotary lævulose is obtained, as shown in the diagram, by fermenting the artificial and inactive fructose with brewer's yeast, in which fermentation the yeast cells single out the ordinary lævulose molecules, decomposing them into alcohol and carbonic acid, while the dextro-rotary lævulose molecules, which are an entire novelty, and of which the yeast organisms and their ancestors have no experience in the past, remain untouched by them. This phenomenon is particularly noteworthy as being the first instance in which the capacity of yeasts to select between two optical isomers has been put to the test. Indeed, this is the first instance of optical isomerism in the sugar group at all.

We must now turn to the second group of recent discoveries in the department of the sugars, which includes the synthesis of sugar containing more than the six atoms of carbon which we find in the natural sugars.

The fascinating problem of thus building up sugars of greater molecular magnitude really depends upon chemical reactions of great simplicity, and which a few minutes' attention will render fully intelligible.

Any of the sugars, whether of the dextrose or lævulose type, can combine with hydrocyanic acid to form an oxycyanide in the same way that ordinary aldehyde and acetone do.

$$\underset{\text{(Aldehyde.)}}{CH_3.CHO} + \underset{\text{(Hydrocyanic acid.)}}{HCN} = \underset{\text{(Oxycyanide.)}}{CH_3.CH(OH).CN}$$

$$\underset{\text{(Acetone.)}}{CH_3.CO.CH_3} + \underset{\text{(Hydrocyanic acid.)}}{HCN} = \underset{\text{(Oxycyanide.)}}{CH_3.C(OH)(CN).CH_3}$$

These oxycyanides, by treatment with caustic alkalies, yield the corresponding oxyacids:

$CH_3.CH(OH).COOH$ and $CH_3.C(OH)(COOH).CH_3$

Applying these reactions to a typical case in the sugar group, we will take dextrose:

$$\underset{\text{(Dextrose)}}{CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHO.} + \underset{\text{(Hydrocyanic acid)}}{HCN.} = CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ \underset{\text{(Oxycyanide)}}{CHOH.\ CH(OH)(CN)}$$

from which is obtained the corresponding oxyacid:

$CH_2OH.CHOH.CHOH.CHOH.CHOH.CHOH.COOH.$

and from this, by reduction with nascent hydrogen (sodium amalgam), is then obtained the corresponding sugar:

$CH_2OH.CHOH.CHOH.CHOH.CHOH.CHOH.CHO.$

containing 7 atoms of carbon, and which we may call *heptose*. From this heptose we can pass by similar reactions to a sugar containing 8 atoms of carbons, or *octose*, and from this, again, to one containing 9 atoms, or *nonose*. This is as far as the synthetical method has hitherto been carried, but there is no reason why it should not be possible to pursue the same processes even much further.

Now, these substances are of more interest from a physiological than a chemical point of view, and already experiments have been made in order to ascertain the attitude of yeast toward them. The results in this direction are extremely remarkable, showing that those sugars are fermentable which contain 3, 6, or 9 atoms of carbon, while the remainder are, without exception, unfermentable.

In concluding this part of the subject, I may fittingly draw your attention to the magnificent collection of sugars which science has revealed up to the present time.

TRIOSE.
$C_3H_6O_3$ . . Glycerose.

TETROSE.
$C_4H_8O_4$ . . Erythrose.

PENTOSE.
$C_5H_{10}O_5$ { *Arabinose. *Xylose. *Rhamnose ($CH_3.C_5H_9O_4$).

HEXOSE.
$C_6H_{12}O_6$ . . Glucose, *d**, *l*, *i*.
Mannose, *d*, *l*, *i*.
Fructose, *d**, *l*, *i*.
Gulose, *d*, *l*.
Galactose, *d**, *l*, *i*.
*Sorbinose.
*Formose.
β—Acrose.
Rhamnoheptose ($CH_3.C_6H_{11}O_6$).

HEPTOSE.
$C_7H_{14}O_7$ . . Mannoheptose.
Glucoheptose.
Galaheptose.
Fructoheptose.
Rhamnoheptose ($CH_3C_7H_{13}O_7$).

OCTOSE.
$C_8H_{16}O_8$ . . Mannoctose.
Glucoctose.

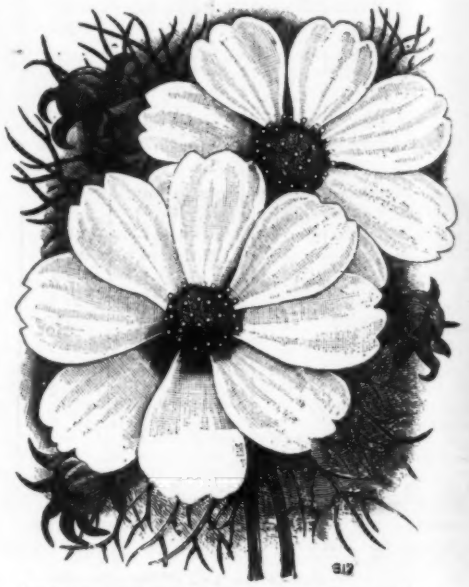
NONOSE.
$C_9H_{18}O_9$ . . Mannononose.

N. B.—In the above table d = dextro-rotary, l = lævo-rotary, i = inactive to polarized light.

Of the 31 sugars in this table, all, excepting 8, are the direct result of the indefatigable zeal and genius of Emil Fischer.

HORTICULTURAL NOVELTIES OF THE SEASON.

THE lists of new plants, fruits, flowers, and vegetables, which form such an important and useful feature of the issue of the *Garden Oracle* for the current year, prove to demonstration that the raisers and introducers of novelties have not experienced to an appreciable extent the depression that has had, and is still having, such an injurious effect upon some of the rural industries. So far from this having been the case, they have shown rather more than the usual degree of activity, for the new plants and flowers are more numerous than for several years past, while the



COSMOS BIPINNATUS GRANDIFLORUS ALBUS.

fruits and vegetables are above the average both in numbers and utility. This is eminently satisfactory, for few things add so much to the enjoyment of the garden as watching the development of any new plants, fruits, or vegetables that may be under trial, and instituting comparison with standard kinds. These trials are not wholly free from disappointments; it would be surprising were it otherwise; but they are more than compensated by the pleasure experienced when a novelty is found to be of undoubted value. It is not, as a rule, desirable that novelties should be grown extensively until it has been proved that they are adapted to the requirements of the cultivator and also suitable for the district, for, with but few exceptions, the various subjects are materially influenced by local conditions. But the more promising each year should be grown for trial, the area being just sufficient to admit a trustworthy opinion being formed as to their merits. With a view to assist those who have but few opportunities for becoming acquainted with novelties we have prepared the following notes, which it is hoped will, with the accompanying illustrations, be useful in making selections from the several classes to which recent introductions have been made.

ADIANTUMS.

Maidenhair ferns of recent introduction are few in number, but they are of much importance, the most noteworthy being *A. capillus veneris imbricatum*, an

LOBELIA FORMOSA.

exceptionally fine variety of the well known indigenous maidenhair fern which has been introduced by Messrs. Dickson's, Chester. This differs from the type in the development of its pinnules, which are as large as those of A. farleyense, and overlap each other. It presents a charming appearance in small pots, is very effective grown as a specimen, and presents an extremely beautiful appearance when planted in suitable positions in the cool fernery. *A. elegantissimum*, raised by Mr. H. B. May, Dyson's Lane, Edmonton, is very distinct and distinguished by its graceful outline and light appearance.

BEANS.

Beans form such a useful class of vegetables that it gives us much pleasure in stating that several excellent varieties have been added to the list. Sutton's Triumph is a distinct dwarf French variety, enormously productive, and bearing large, handsome pods that would render substantial service in a close competition. It is one of the most valuable dwarf varieties of its season, and that we are not singular in our opinion we would mention that the stock was completely sold out within a short time of the seed catalogue being issued. Sutton's Forcing is exceedingly useful for pot culture, being about a week earlier than Osborne's Early Forcing, has larger pods and is more productive. Of a very distinct character to the foregoing is Webb's Golden Queen, an excellent selection, dwarf in growth, and bearing a profusion of bright yellow pods which are of excellent quality. Undoubtedly one of the best of the dwarf butter beans, and chief among the runners belonging to the same class, is Webb's Golden King. The new varieties belonging to the scarlet runner type include Hill's Prize, a remarkably fine selection, bearing very fleshy pods of medium size, and enormously productive, introduced by Messrs. George Bunyard & Co., and Carter's Elephant, a distinct selection, remarkable

TORENIA, WHITE WINGS.

for the large size and handsome appearance of the pods.

CHRYSANTHEMUMS.

Varieties of recent introduction have been so fully reported upon in these pages by Mr. E. Molyneux and Mr. E. Beckett, that it is not necessary to do more than briefly to refer to James Shrimpton, a very distinct Japanese variety, introduced by Mr. N. Davis. It may perhaps be best described as a much enlarged Cullingfordi, the blooms being somewhat similar in form and of the brilliant crimson scarlet hue which has done so much to popularize that well known variety. For the front row it will be found of exceptional value; while W. Seward, a rich crimson Japanese, also raised by Mr. Seward, and introduced by Mr. Davis, will be found equally useful for the middle and back rows, by reason of its effective color.

DELPHINIUMS.

Perennial larkspurs have been greatly improved of late years, and now constitute a very distinct and beautiful group of plants for the herbaceous border. Their usefulness for exhibition has also been materially increased, the finer forms being very effective in a cut state, as demonstrated by Messrs. Kelway & Sons, at the summer meetings of the Royal Horticultural Society. A short sketch of the history of the delphinium,

CHRYSANTHEMUM, J. SHRIMPTON.

tracing its development during the past twenty years, would be of much interest, but space will not permit of our doing more than briefly indicating the new varieties of exceptional merit. These are: Etoile, double, deep blue shaded lavender, flowers large and full; James Kelway, violet blue, with clear white center, flowers large and borne in stately spikes; Orpheus, semi-double lavender, very pleasing; Puck, semi-double, bronze-purple, flowers large, desirable for its distinctness; Princess May, semi-double, mauve shaded at the margin with azure blue, and with dark center; Robin Adair, semi-double, bright blue, suffused purple and with dark center, very fine; Sailor Prince, single, deep blue and purple, flowers very large and produced in spikes of noble proportions; Sir R. Paget, semi-double, lavender blue with white center; S. G. Cleveland, semi-double, violet-purple relieved by white center; and Uta, semi-double deep purple with marone

SUNFLOWER, SUTTON'S PRIMROSE PERFECTION.

center. These have all a robust habit, and under favorable conditions produce well branched spikes rising to a height of 6 or 7 ft. To have delphiniums in perfection they should be planted in soil that has been liberally enriched with manure and deeply stirred, and after they are established be assisted with top dressings of farm yard manure or some artificial fertilizer. It is desirable also to thin the shoots somewhat rigorously, more particularly after they have formed large shoots.

COSMOS.

Another new and very desirable addition to our new half-hardy annuals is the white Cosmos, which Messrs. Daniel Brothers, of Norwich, have introduced. Very few species of Cosmos are grown in gardens, they are all Mexican plants, and very free bloomers. C. scabiosoides is a perennial, and requires similar treatment to that given to dahlias, it has large scarlet flowers. C. tenuifolius has finely divided leaves and deep purple flowers; C. bipinnatus is an annual, which was introduced nearly one hundred years ago, but little improvement has been made with it until recently. The variety grandiflorus albus, of which we give an illustration, is the new one sent out by the Norwich firm, it grows

SINGLE DAHLIA, MARGUERITE.

about 3 ft. high, and has finely divided foliage. The flowers are very numerous, and borne on long stalks; being pure white, they will be useful for decorative work, and we understand that they last a long time in a cut state. Seed should be sown of the annual species and varieties in March or April, and the seedlings transplanted in June, when they will soon commence to bloom, and continue to do so until cut down by frosts.

DAHLIAS.

Many firms have taken up the improvement of the dahlia with much vigor and patience, new colors are constantly coming before us, and new forms of flowers occasionally appear. Perhaps the most distinct break in this popular class of florists' flowers is that raised by Mr. Girdlestone, and sent out for the first time by Messrs. Cheal & Sons, Crawley, Sussex. This section, known as the Tom Thumb dahlias, comprises many varieties and various colors, all the plants are uniformly dwarf, and consequently well adapted for summer bedding. These Liliputians seldom exceed one foot in height, are wonderfully free flowering, and comprise some dozen or more colors. All the varieties have single blooms. For edging large beds or borders they can hardly be excelled, and we give an illustration to show their distinct character. Two very handsome pompon varieties were exhibited by Mr. Charles Turner, of Slough, last autumn, which should become very great favorites. Amber has beautiful orange flowers, and Gypsy Queen has small dark marone ones. Mrs. Vagg is a compact medium sized show variety, quite an unusual bright satiny purple color, introduced by Mr. F. A. Rawlings, Romford. Messrs.

KALE, SUTTON'S A1.

Keynes, Williams & Co., of Salisbury, have raised some charming new varieties, chief among these being Bertha Mawley, a splendid cactus form, with brilliant crimson and magenta flowers; Countess of Radnor, cactus, yellow and bright carmine; Countess of Gosford, yellow and salmon; and Mrs. Basham, a cactus variety with twisted florets, a remarkably elegant production, with bright rose florets shading to deep yellow at the base; the flowers have a delightful, glowing appearance.

The single dahlia, Marguerite, is quite distinct in form from the ordinary types; it is a loose flower, pure white, and has long stalks, which render it suitable for all kinds of decorative work. Messrs. Cannell & Sons are introducing other single varieties of merit in Duke of York, an orange scarlet variety, with a yellow ring round the disk; Yellow Satin, a clear yellow form, certificated last year; Kitty, white, suffused with mauve; Jack, dark marone, a very beautiful variety; and Fred Leslie, red tipped with white, a distinct free-blooming form. The three last mentioned varieties have been raised by Mr. T. W. Girdlestone.

KALES.

Kales of distinct character are so seldom introduced that new types giving promise of proving useful additions to their class are deserving of special attention. One of the most noteworthy of the recently introduced kinds is Earley's Hardy Curled Sprouts, now being distributed by Messrs. B. S. Williams & Son. This was obtained as the result of a cross effected between the Brussels sprouts and the Scotch kale, and combines in a remarkable manner the good qualities of these two vegetables. The habit is similar to that of the first-mentioned, the sprouts are compact, and the leaves are distinctly curled, showing the influence of the kale. The sprouts are of good color, and delicate in flavor when cooked, and make a dish at once elegant and ac-

DELPHINIUM, ROBIN ADAIR.

ceptable. One of the chief recommendations of this borecole is the late period in the season at which it is available for the table; in ordinary seasons the sprouts may be gathered in good condition until within a short time of the spring cabbages being ready for use. It is, indeed, so distinct and good that it should certainly have a place among the novelties selected for trial in the kitchen garden. Of a quite distinct character, and not less remarkable in its way, is Sutton's A 1 Kale, an exceptionally fine selection of the type represented by the Scotch kale. It is rather robust, and very compact in growth, and, as so well shown in the accompanying

DOUBLE PELARGONIUM, MRS. H. J. MILLS.

illustration, the leaves are very densely curled. It is unquestionably the finest of the curled varieties for exhibition, the deep green elegant, moss-like heads presenting a distinct and pleasing contrast to the various roots which usually form the principal part of collections of vegetables at the autumn exhibitions. Sutton's Arctic Purple Curled, although not strictly new, has proved so valuable during the recent severe winters that it is well deserving the most widely extended culture. In several places where Brussels sprouts and kales generally were much damaged by the severe

NICOTIANA COLOSSEA.

weather experienced during the past three winters the Arctic Purple Curled has not been in the slightest degree injured.

LOBELIAS.

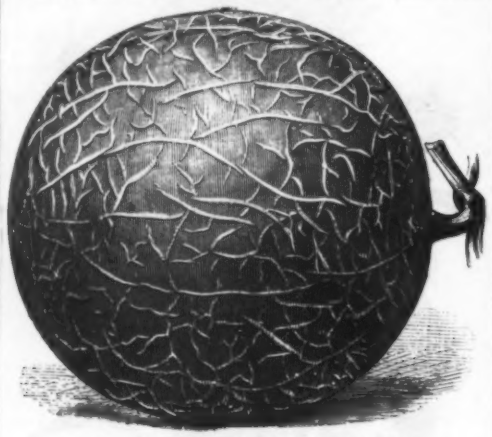
Among bedding lobelias we have a departure from the blues and the whites, in the case of a variety Mr. W. Bull is distributing. Lobelia formosa, as the new comer is named, is in habit very similar to the well known L. speciosa; the flowers are large and deep ruby

TOMATO, LADY BIRD.

scarlet; being very dwarf and so distinct in color, it should find favor with those who have summer bedding to attend to. Many years ago Mr. Bull sent out purplish crimson varieties of lobelia known as Omen and Ruby, which were well known in their day. In addition to the first mentioned in this note, Mr. Bull has a variety named Barnard's Perpetual which received an award of merit from the Royal Horticultural Society, at the Temple Show in 1892. It is brilliant blue with white marking, and its strikingly distinct and ornamental character attracted very considerable attention on the occasion of its exhibition. Messrs. H. Cannell & Sons, Swanley, Kent, have introduced a bedding lobelia which will doubtless be much used by those who have a penchant for novel effects. This particular variety is a very gay one, notwithstanding its name of *L. erinus compacta aurea goldelse;* the flowers are bright blue and the foliage is golden yellow.

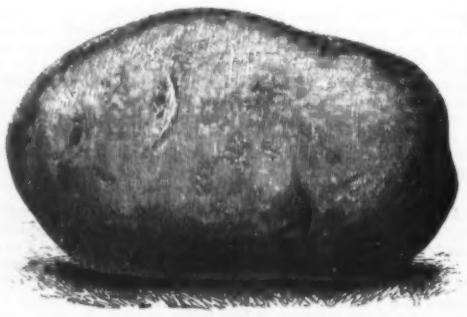
MELONS.

The melons introduced for the first time this season



MELON, GUNTON ORANGE.

are rather numerous, and are on the whole so good that there is not one that is indifferent among them. First mention may well be made of Gunton Orange, a scarlet flesh variety, raised by Mr. W. Allan, of Gunton Park, and now being distributed by Messrs. J. Veitch & Sons. The fruit is of medium size, and globular in form, the skins bright yellow and freely netted, the flesh bright red, thick, firm, and extremely rich in flavor. It may be added that the plant has a good constitution, and sets freely, and that the variety had a first-class certificate conferred upon it by the Fruit Committee of R. H. S., May 17, 1892, when it created much interest. Ritching's Perfection, also introduced by Messrs. Veitch, is a useful addition to the green



POTATO, DANIELS' DUKE OF YORK.

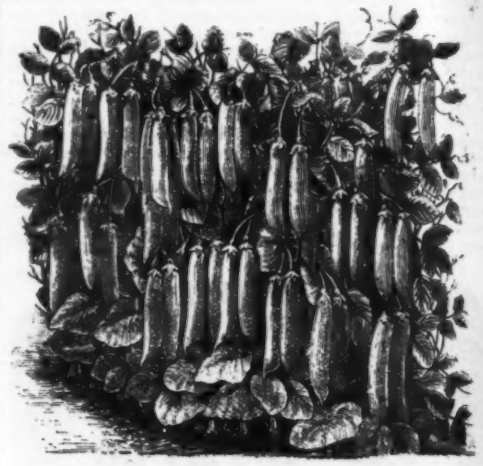
flesh varieties; the fruit of medium size, with golden, handsomely netted skin, and exceptionally thick and richly flavored flesh. Webb's President is a desirable addition to the white flesh melons, the fruit being large, handsome, and of high quality. Carter's Hölborn Favorite, raised by Mr. Pettigrew, of Cardiff Castle, and introduced by Messrs. J. Carter & Co., is a welcome addition to the green flesh class. The fruits are of large size, roundish ovate, with finely netted skin, and exceedingly rich in flavor. Not less noteworthy is Westley Hall, a handsome and highly flavored scarlet flesh variety, introduced by Messrs. Daniels Bros. In but few gardens will it be practica-

WEBB'S GOLDEN QUEEN BUTTER BEAN.

ble to grow the whole of these varieties without unduly displacing the established kinds, but having briefly indicated the characteristics of each we can leave the selection to our readers with the full assurance that they will be well satisfied with the choice made.

NICOTIANAS.

This genus is a valuable one horticulturally. Many species are used largely for producing effect in sub-tropical bedding at home, and for many other purposes on the Continent. We are all acquainted with the beautiful N. affinis, which is so easily grown from seed, and whose white, sweet-scented flowers are produced so freely, making it suitable in every way for the ornamentation of the greenhouse or conservatory. N. fragrans has also fragrant flowers; N. glauca is a shrubby species with yellow flowers, and grows to a great height; N. suaveolens is a very free flowering

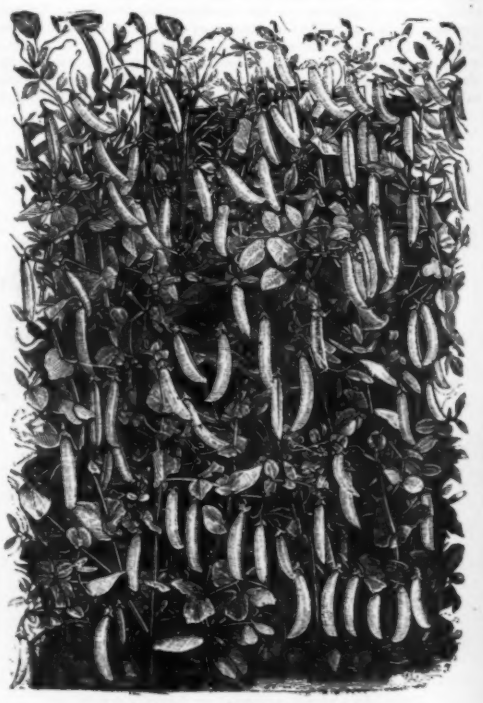


PEA, CARTER'S DAISY.

Australian herb; while the "tobacco," N. tabacum, is a common object in the borders of our gardens and parks during the summer and autumn. N. wigandioides is a species with large, bold leaves, and one well suited for sub-tropical bedding. *Nicotiana colossea*, or *N. tomentosa* as it is named in the *Botanical Magazine*, t. 7, 252, is a later introduction, which merits all eulogies which it has received. A stock is readily raised from seed, which may be obtained from most nurserymen. The figure here given admirably portrays the character of the plant. The leaves are three feet in length and twenty inches wide, and when young are beautifully tinted with violet and red, eventually becoming glossy green with red veinings. They are much tougher than other species, and consequently less likely to be damaged by storms and winds when used out of doors. Besides the latter use, N. colossea will prove useful for planting out in large conservatories, winter gardens, etc., as it often attains a height of ten feet. The flowers are borne in panicles; the calyx and tube are green, while the inflated end and spreading segments of the corolla are yellowish.

PELARGONIUMS.

One of the most distinct zonal pelargoniums that has lately been raised is the double variety, known as Mrs. H. J. Mills, which Messrs. H. Cannell & Sons, Swanley, are sending out this year. This novelty is a sport from Vesuvius, and has scarlet flowers, striped with white, and with white center; it is wonderfully free, and produces its trusses throughout the winter. It is to be largely exhibited this year. Madame Melba is a beautiful new variety, with large soft pink flowers. Blue Peter is a single pelargonium, raised by Mr. Miller, and is the nearest approach to a blue variety that we have



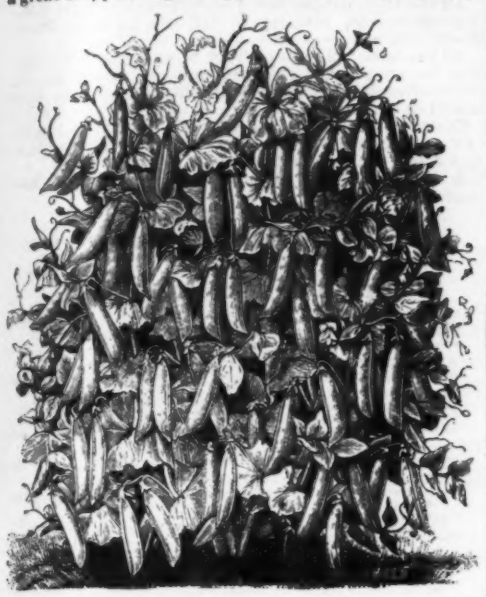
PEA, SENATOR.

yet seen; the flowers are of good size and form, with a white eye. Messrs. Cannell & Sons are introducing some splendid new double forms in Lord Tennyson, which has fiery salmon flowers; Colossus, raised by Mr. Miller, rich reddish crimson; and F. V. Raspail, improved; this variety is a remarkable one, the flowers are very fine, and being more than two and a-quarter inches across, are sufficient individually to form a button hole bouquet for a gentleman; the trusses are

large, and stand well above the foliage, and are deep orange color. It had an award of merit from the Royal Horticultural Society last year.

PEAS.

Peas of recent introduction are, as usual, very plentiful, and it is satisfactory to know that they are somewhat above the average in utility, and that they include a considerable number of varieties of exceptional merit. Carter's Daisy may well be described as a valuable addition to the dwarf wrinkled marrows, for it is a great cropper, of good appearance, and high quality.



PEA, ENGLISH WONDER.

The height ranges from fifteen to eighteen inches, and the pods are about four inches in length, slightly curved, and tightly packed with large peas, which are of a deep green color and rich in flavor. As it gives a heavy return in proportion to the space occupied, and the pods are of good appearance, it will, unless we are much mistaken, become very popular both for the private and market garden. This variety was obtained by first crossing Culverwell's Giant Marrow with Stratagem, and then crossing the selected progeny with the last named variety. We had an opportunity of seeing some three or four acres of Daisy pea in the seed ground of the firm at Bromley in the course of last summer, and the crop was prodigious, the haulm being literally propped up by the pods. Another very dwarf variety of special merit is Cannell's English Wonder, a first early wrinkled marrow of the highest excellence. It Chiswick trials, and the tubers are large and handsome and the quality attains a height ranging from twelve to fifteen inches, and is so productive that as we saw the crop last summer on the sunny slopes of the seed farms of the firm at Eynsford the haulm was literally smothered with the pods. These are about three inches in length, and well filled, each pod containing eight or nine peas, which are of a deep green color when cooked, and of excellent flavor.

Another early variety deserving special attention is *Sutton's May Queen*, a dwarf, wrinkled marrow equal in earliness to the second early, round seeded peas with which we have so long been familiar. The variety attains a height of thirty inches, is a very good cropper, and the pods, which are of medium size, are well filled. Mr. Douglas describes it as a week earlier than Laxton's Alpha, which he has hitherto grown for the first supplies of peas of good quality. It will be found especially useful for sowing in summer for autumn supplies, and will soon take the place of the majority of the varieties now sown in the summer for that purpose. *Sutton's Invincible* is a main crop variety attaining a height of about thirty inches and remarkable for its vigorous growth and productiveness and for the large size of the pods and the high

POTATO, BOSTON Q.Q.

quality of the peas. Of great excellence also is *Sutton's Magnum Bonum*, a distinct variety attaining the same height as the last named and producing immense crops of large well filled and exceedingly handsome peas. This should prove useful to growers for market as well as in the private garden, and it is of undoubted value for exhibition. *Holloway Victory*, introduced by Messrs. B. S. Williams & Son, is a distinct wrinkled marrow attaining a height of six feet, and will be much appreciated by those who prefer the tall kinds. Our coadjutor, Mr. R. Weller, who grew it for trial last year, describes it as being a heavy cropper, of delicious flavor, and not subject to mildew, and states that "it has no equal." Even taller than the last named is *Day's Conundrum*, an excellent variety, introduced by Messrs. Cooper, Taber & Co., which in good soil attains a height of seven feet. It is robust in growth and exceptionally productive, while the quality leaves but little to be desired, the peas retaining their rich flavor until they have attained their full size. *Webb's Senator*, obtained as the result of a cross between Prince of Wales and Culverwell's Giant, is an excellent wrinkled marrow ranging from three feet to three and a half feet and producing in great profusion large and handsome pods containing eight or nine peas each, especially useful for gardens of small size. *Webb's Talisman* is a valuable addition to the varieties averaging five feet in height. It belongs to the blue wrinkled class, is a heavy cropper, and of excellent quality. *Laxton's Alderman* belongs to the same section as the last named and is very similar in height. As a main crop variety of the highest class it well deserves the attention of the general body of cultivators, while the immense size and handsome appearance of the pods should commend the variety to the notice of those who take part in competitive gatherings. *Laxton's Gradus*, a wrinkled marrow, attaining a height of about three feet, is distinguished by its earliness, productiveness, and high quality. It gives supplies at the same time as William I., but the pods are equal in size to those of Duke of Albany, and the quality is decidedly high.

POTATOES.

The potatoes now being distributed for the first time are even more numerous than the peas, and include a considerable number of varieties of undoubted excellence. One of the most remarkable of the novelties is *Early Laxton*, raised and introduced by Mr. T. Laxton. This is described as having been obtained from a cross between White Beauty of Hebron and Myatt's Prolific, and has had a first class certificate conferred upon it by the Royal Horticultural Society. It has short haulm, and is a heavy cropper, the tubers longish round, with white skin and handsome. A valuable early variety both for frame and open border culture. *Sutton's Supreme* is a notable addition to the second earlies, and will be a fitting companion to the many high class varieties introduced by the well known Reading firm. It is a prodigious cropper; the tubers are large, pebble shape, occasionally russeted, and very handsome, while the quality is unsurpassed. *Webb's Express* will be found a welcome addition to the early kidneys, and promises to take a high position in its season. It was raised from Beauty of Hebron, and is a heavy cropper, the tubers oval shaped with clear skin and a firm white flesh. *Boston Q.Q.*, raised by Messrs. Johnson, of Boston, is a distinct round variety belonging to the type represented by the Regent, and

POTATO, EARLY LAXTON.

is of the highest value. It is described as a seedling from Lord Tennyson, is a heavy cropper, as so well exemplified in the remarkably high, as indicated by the fruit committee of R.H.S. conferring a first class certificate on it. As it is ready for digging immediately after the first early kidneys, it should be useful for market culture. *Daniels' Duke of York* is a white kidney variety, raised by Messrs. Daniels Bros., of much value for second early supplies. It has been obtained from a cross between Early Primrose and King Kidney, and has short compact haulm and large oval tubers, which are remarkably handsome and of high quality. It is a heavy cropper, as proved by the fact that sixteen tons per acre have been obtained with ordinary good culture. *Wheeler's Alderman* is a valuable addition to the main crop varieties, combining productiveness, high quality, and good appearance in a remarkable degree. From the several excellent varieties raised and introduced by Mr. H. Fletcher should be selected *Lillie Langtry*, an attractive colored kidney, and *Crown Jewel*, a handsome white round, which are of the highest promise.

RADISHES.

The radishes have undergone considerable improvement of late years, and one of the most noteworthy of the recent additions is *Webb's Favorite*, a long-rooted variety remarkable for its quick growth and delicate flavor. The roots are somewhat shorter than are those of the well known long kinds and are of greater thickness, and very crisp and tender.

ROSES.

New roses, as is customary, are contributed in large numbers by the Continental raisers, but it would be premature to offer any opinion upon them at the present time, and we shall refer only to the more important of those raised in the United Kingdom. Foremost among the new roses of the season are *Clio* and *Corinna*, raised and introduced by Messrs. William Paul & Son. Clio is a hybrid perpetual of the most distinct character, vigorous in growth, with ample foliage and large globular finely formed flowers of a delicate flesh color, deepening to pink in the center. Corinna belongs to the tea section and is unquestionably a valuable addition to its class. It is comparatively hardy, vigorous in growth, and the large handsome flowers are exquisitely shaded with rose and coppery yellow, flesh colored ground. *Lady Henry Grosvenor*, a hybrid perpetual, sent out by Messrs. W. Paul & Son last season, is so meritorious that we thought it desirable to again refer to it. This fine rose was raised by the late Mr. Henry Bennett, and has proved specially useful for garden culture and forcing. The flowers are large, globular, and of a delicate flesh pink. *Marchioness of Londonderry*, a superb hybrid perpetual, raised by Messrs. A. Dickson & Sons, must be included in these notes, but it is not necessary to do more than mention it, as we gave an illustration with full descrip-

RADISH, WEBB'S FAVORITE.

tion in December last. *Turner's Crimson Rambler*, a polyantha variety introduced from Japan, which is to be distributed by Mr. Charles Turner in the autumn, is of exceptional value for the garden, the plant being vigorous and the small brilliant crimson flowers freely produced in enormous clusters.

STRAWBERRIES.

These delicious fruits have been augmented by several varieties of great excellence. Chief among them is *Laxton's Sensation*, a very distinct second early variety, remarkable for the large size and high quality of the fruit. The latter is similar in character to that of President, but much larger, and the skin and flesh are of a rich crimson hue. The large size of the fruit should commend the variety to the notice of growers for exhibition. *Gunton Park* and *Lord Suffield*, raised by Mr. W. Allan, and introduced by Messrs. J. Veitch & Sons, are deserving of special attention by reason of their productiveness and exceptionally rich flavor. These two varieties were described and figured in our last volume, and the briefest reference to them will therefore suffice on the present occasion.

SUNFLOWERS.

The annual sunflowers are so easily grown by every one, from the peasant to the peer, that any distinct variety which possesses a free flowering habit must assuredly come into general favor. The *Miniature* sunflowers have received much attention and been improved considerably by those establishments who raise annuals in quantity for seed distribution. This variety is about four feet high, differing considerably in stature from the old giants, which expanded enormous

H.T. ROSE, LADY HENRY GROSVENOR.

golden heads some eight or ten feet from the ground. Between these two extremes we have *Primrose Perfection*, a much branched variety, with large flowers, freely produced; the center is black, which sets off to the best advantage the broad primrose colored rays. The height of this variety is usually six feet. The accompanying illustration gives the true character of this novelty, which Messrs. Sutton & Sons, of Reading, are distributing in the usual course of business.

SWEET PEAS.

The remarkable diversity of color which sweet peas now afford is very largely due to the patient and persevering energy of Mr. Eckford, of Wem, Salop. Sweet peas can be grown true from seed, and lovers of these annuals will find more enjoyment from a few rows of good named varieties than is to be obtained from the ordinary mixed seed. Those who were fortunate enough to see the collection growing at Chiswick during the past summer will remember how fine are the flowers, how strong is the constitution, and how distinctly the colors are being developed in those varieties emanating from Wem. Of the dozen varieties of Lathyrus odoratus which have received awards from the Royal Horticultural Society, eleven were Mr. Eckford's productions, and on three occasions his strain was certificated by the same society. Probably at no very distant date Mr. Eckford will be able to place a distinct yellow, or perhaps golden, sweet pea upon the market. The tendency is in that direction at any rate, for in the variety *Mrs. Eckford* we have flowers of large size and pale primrose in color, the unopened buds are brighter than the expanded flowers, and give a yellow glow to a row in bloom. *Lady Beaconsfield* is one of the latest additions, with pale rose wings and primrose standards; *Her Majesty* is in our experience the largest flowered variety yet produced; it is particularly grand and handsome, the color being soft rosy pink shading to magenta. *Countess of Radnor, Dorothy Tennant, Boreatton, Mrs. Gladstone, Captain of the Blues,* and *Mrs. Sankey* make up a fine selection. We trust that Mr. Eckford may long continue to improve and popularize these lovely flowers. Mr. Thomas Laxton, of Bedford, is offering several new sweet peas of his own raising that are of fine form and color. Among them *Carmen Sylva* is the most attractive, its heliotrope blue wings and carmine standard give the flower a combination of colors which cannot fail to please, especially with the ladies; *Madame Carnot,* a pretty blue variety, with a curious metallic shade; *Etna,* a larger form of Vesuvius, with more intense coloring; *Rising Sun* is a curious form, the wings are pale rose shading to white, the standards are peculiar, having splashes and spots of carmine, orange, and rose.

TOMATOES.

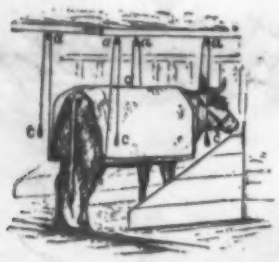
These occupy, as usual, a prominent position among novelties, and include several excellent types. Especially noteworthy is *Lady Bird,* raised by Mr. Leach, of Albury Park, and now being introduced by Messrs. J. Veitch & Sons. The variety is a very heavy cropper, and sets its fruit early in the year. The fruits are of medium size, perfectly smooth, very solid, and of a bright crimson color. It was awarded a first class certificate by the Fruit Committee of R. H. S. in October last. Another tomato which obtained similar distinction is *Collins' Challenger,* a variety of the Conference type, but a heavier cropper, and producing larger and more handsome fruits. For supplying the table this fine tomato can be strongly recommended.

TORENIAS.

Few prettier effects are produced in the warm greenhouse or conservatory than that of a basket of well grown plants of torenias when blooming freely; the peculiar structure of the flowers and the deep contrasting colors they possess so impress one with their beauty that once seen we never fail to remember a torenia. Very few species and varieties are cultivated; propagation by seeds or cuttings is easily effected; seed should be sown in March or April to produce strong plants. Those best known are T. asiatica, flowers blue and violet; T. concolor, violet blue; T. flava, improperly called T. Bailloni, with pretty yellow flowers, and a purplish eye; T. Fordi, with pale yellowish flowers blotched with violet. Perhaps the best known species is T. Fournieri. It has large violet and yellow flowers, and has a pretty golden blotch on the lower lip. A glance at any list of torenias will show that the addition of a white one would be very welcome. Such an addition has now appeared. *White Wings* is the name of this sport from T. Fournieri; the flowers are pure white, with a flush of soft rose in the throat; in every other respect it is similar to the species, and, like it, will form excellent subjects either for pot or basket culture. Mr. Bull is offering this new and welcome variety.—*The Gardeners' Magazine.*

BLANKET WITH WEIGHTS.

SOME years ago, on a visit to Iowa during the winter, my attention was called to the difficulty of keeping



animals warm. I then devised a plan, which I herewith explain. The object is to have a covering that cannot get under foot or out of position. A A A A are sheaves. Cords attached to the four corners of the cover pass through the sheaves, with weights attached at opposite ends, C C C C. On each side of the cover, longitudinally, are stretchers to keep the cover in position. By making these stretchers heavier than the weights, the cover always remains in position, falling when the animal lies down, and rising with him. This cover could be of sacking or cheap padded stuff, as it could not get under foot or be torn.—*W. R. H., in Country Gentleman.*

CHEMISTRY OF THE STOMACH.

THE function performed by the free hydrochloric acid in the stomach appears, according to Dr. A. L. Gillespie, to differ in some points from what has been generally understood. On effecting artificial digestion with dialyzers the results obtained indicated that proteids in solution possess the power of attracting, and probably combining with, this acid; that, when so combined, the latter does not prevent free acid from dialyzing; and that it does not combine with carbohydrates. The following are some of the conclusions arrived at after experimenting on a neurotic dyspeptic, in whom there existed conditions of normal acidity. Free hydrochloric acid is secreted by the gastric glands from the time that food enters the stomach, the time at which it appears varying with the composition and concentration of the food, as well as the state of the mucous membrane. The acidity in the initial stage of gastric digestion is too small to stop the amylolytic action of saliva, and the free acid secreted at first combines at once with the proteids present in the food, the proteid-hydrochlorides formed exerting less antiseptic power than the free acid. The stomach contents have no further digestive power unless there be free acid present; the total acidity may vary from 0·108 to 0·36 per cent., combined acidity from 0·072 to 0·324, and free acidity from 0·018 to 0·09; heartburn is never caused by hydrochloric acid combined with proteids; and the acidity of the stomach contents and that of the urine is often inversely proportional.—*Pharm. Jour.*

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